ATERWORKS NUMBER

MAY 31, 1934

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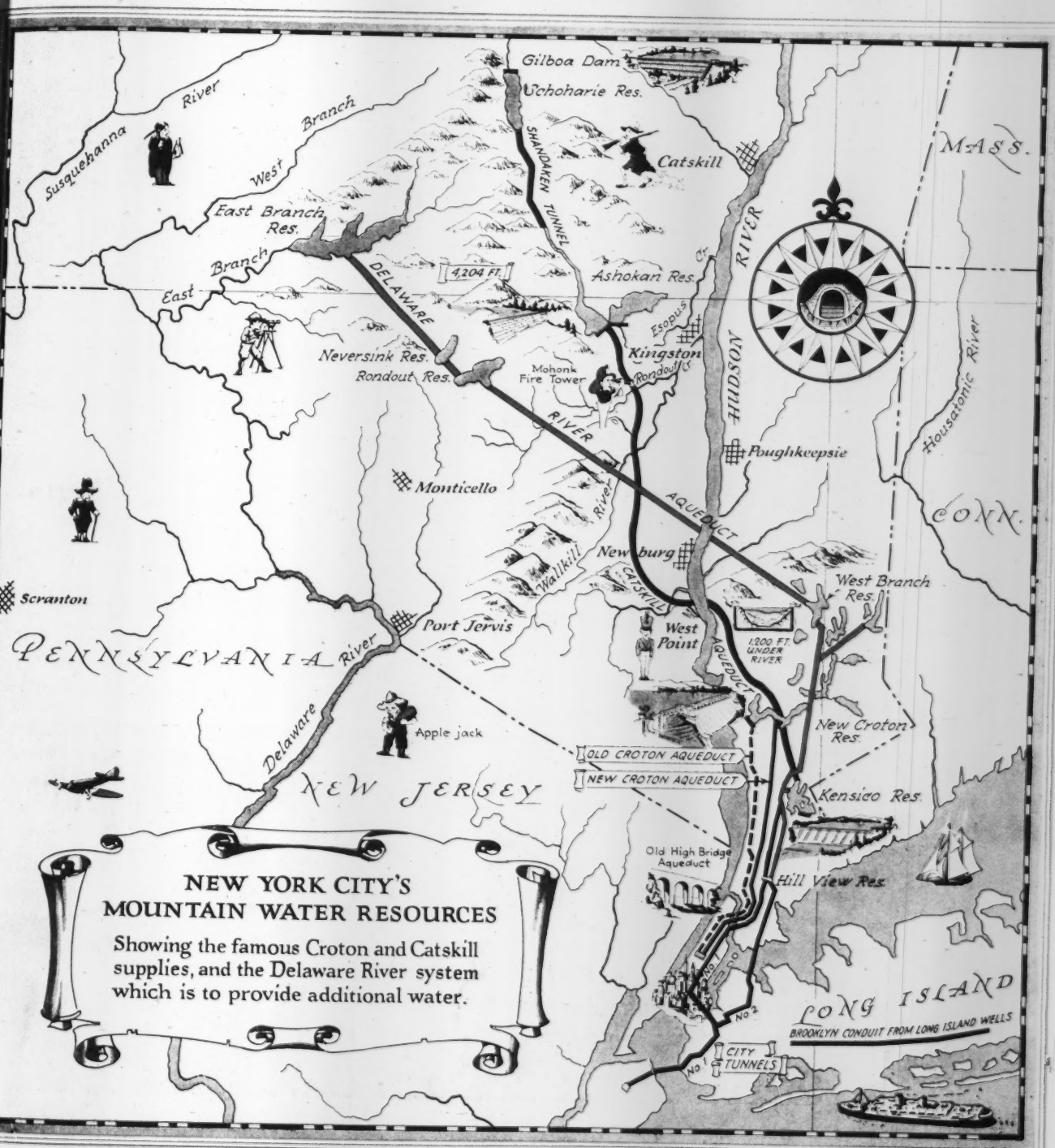

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CONTENTS FOR ANNUAL WATERWORKS NUMBER MAY 31, 1934

VOLUME 112 NUMBER 22 COPYRIGHT, 1934

Water Service Improvements.....684
BY W. W. BRUSH; M. C. SMITH; S. M. VAN LOAN

PWA Helps Finance a New Water Supply....690
BY FARLEY GANNETT

Building the Wilmette Filter Plant.....692

New York City's Deficient Water Supply.....698
BY WALTER E. SPEAR

Treatment of New York City's Water Supply..703
BY FRANK E. HALE

Treatment Problems for Mid-West Waters...707
BY N. T. VEATCH, JR.

Milwaukee Plans a Filter Plant.....709
BY L. R. HOWSON

Detroit's Water Finances in the Depression....712
BY CLARENCE W. WRIGHT

Rate Structures for Municipal Waterworks....715
BY ARTHUR W. CONSOER

Editorials 718

Current News 720

New Equipment 726

In the News:

INTEGRATION of all state societies of professional engineers into a single national society received the endorsement of the New York state society last week. Planned ultimately to supplant the American Association of Engineers, the new national body will concentrate on developing strong state organizations and on promoting nationwide licensing of engineers.

NON-STOP, Denver to Chicago, 1,015 miles, 13 hr. 5 min.; average speed 77.6 m.p.h. Such is the record made on May 26 by the diesel-powered streamline train of the Burlington railroad. "The Zephyr" also maintained a speed of 90 m.p.h. for 100 miles, and for 3 miles averaged 112.5 m.p.h. Twelve hours was saved over the usual Denver-Chicago time, by sidetracking all regular passenger and freight trains.

ATLANTA will be the site of the first federal housing construction. The Public Works Emergency Housing Corp. now holds title to all land for the University Project and has options on 70 per cent of the land for the Techwood Project. Meanwhile, according to Administrator Ickes, satisfactory progress is being made in other cities (no names given).

EUCLID, OHIO, where the government has loaned money for individual homes, has five houses complete, nine under way, and twelve conditional applications on file. Fifty more applications would be made if the $5,000 maximum loan were raised to $6,000, it is said.

NEW YORK'S WEST SIDE elevated express highway will be extended beyond 72nd St., and the New York Central tracks will be depressed between 30th to 60th Sts. as a result of a bill signed last week by Governor Lehman. It provides for loaning the railroad company an additional $7,000,000, a loan of $6,500,000 already having been authorized. The state will contribute $6,500,000 to the $20,000,000 project, which will be divided $3,700,000 for the elevated highway and the remainder for railroad rerouting.

In This Issue:

NEW YORK CITY, with one of the most notable water-supply systems in the world, is host next week to the annual convention of the American Water Works Association. To celebrate this event, our cover this week is a map showing the famous Catskill Aqueduct, with its mountain reservoirs, and also the proposed Delaware River supply, destined to be equally famous. The territory covered is rich in history and legend as well as in engineering achievement.

PROBLEMS of the water service engineer during a period of national emergency is the theme of this special waterworks number. Making improvements, collecting bills and planning for the future are the three phases of the subject considered:

William W. Brush, chief engineer, department of water supply, gas and electricity, New York, tells how waste was reduced by stopping underground leaks.

Marsden C. Smith, engineer of water and electricity, Richmond, Va., describes how operation betterments have raised the plant capacity by 50 per cent.

Seth M. Van Loan, deputy chief, bureau of water, Philadelphia, outlines the extensive work done with CWA workers in reconditioning the city's water system.

Pittsburgh strengthened its distribution system, Buffalo extended its high-pressure fire protection, Detroit laid new pipe and painted buildings, Cleveland and St. Louis repaired filters and Minneapolis and Chicago conducted leak surveys.

Farley Gannett, consulting engineer, Harrisburg, Pa., describes how a new water supply for Shippensburg, Pa., was constructed under PWA auspices.

Wilmette, Ill., built a new 6-m.g.d. plant with RFC funds. The financing difficulties were novel, and the plant includes several unusual features and required difficult construction.

Walter E. Spear, acting chief engineer, board of water supply, New York City, looks into the future and sees the immediate necessity for developing the Delaware River supply.

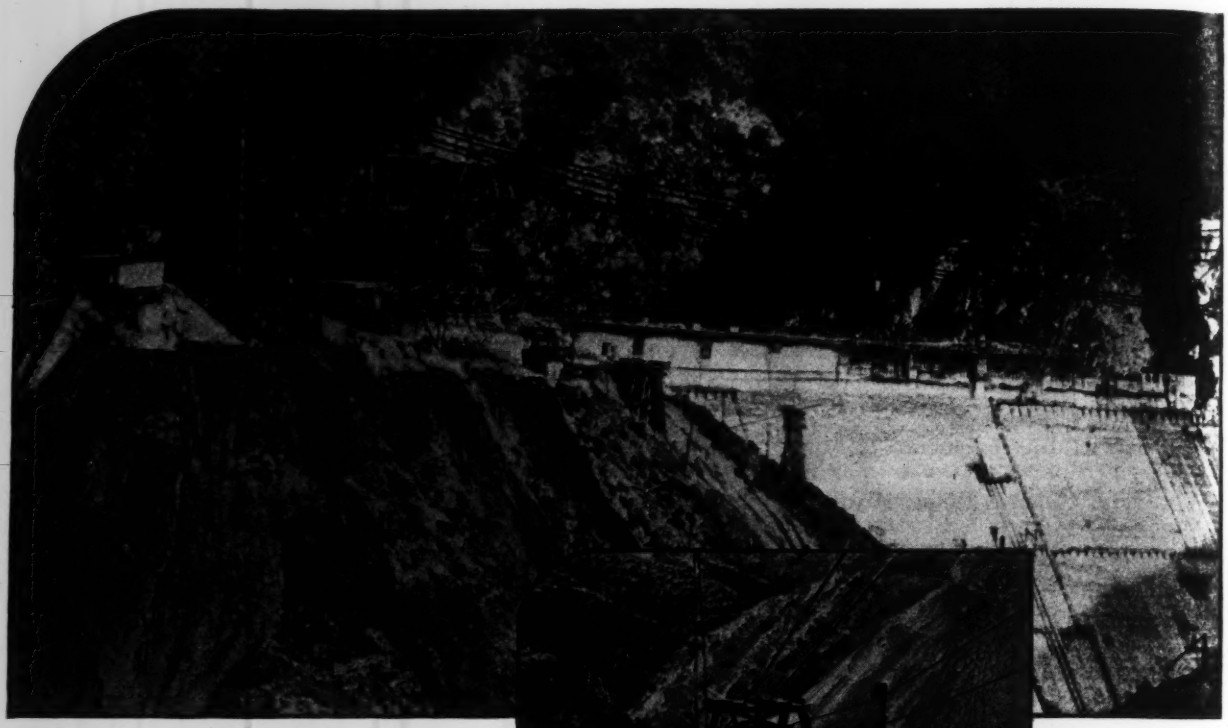
Frank E. Hale, director of laboratories, department of water supply, gas and electricity, New York City, describes the types of treatment required for the city's wide variety of waters.

N. T. Veatch, Jr., consulting engineer Kansas City, Mo., outlines the difficulties of treating the turbid, polluted and hard waters of the Middle West.

L. R. Howson, consulting engineer, Chicago, presents the plans for a 200-m.g.d. purification plant, which will furnish Milwaukee with filtered Lake Michigan water.

Clarence W. Wright, assistant civil engineer, department of water supply, Detroit, reveals the story of the city's struggle with finances as a result of the depression.

Arthur W. Consoer, consulting engineer, Chicago, suggests a rational rate structure for municipal waterworks, in the light of modern conditions.



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ENGINEERING NEWS-RECORD

ANNUAL WATERWORKS NUMBER

New York, May 31, 1934

New Water Service Tasks

WE ARE PASSING through a period of unexampled stress in the maintenance of essential public services. Along with the extreme retrenchment of the past few years there came a bewildered uncertainty about the future of communities and their economic organization. These conditions bore heavily on water supply, and now those engaged in its service find themselves reviewing their experiences and looking forward to their coming tasks.

In the light of recent events many responsibilities of public water-supply service are seen with new clearness. Shortsighted or neglectful administration may paralyze community efficiency; it may even lead to catastrophes of conflagration or epidemic. Thorough maintenance so that operation may reach maximum economy and efficiency is a first essential. A watchful eye to the future is necessary. There must be wisdom to assure income and funds adequate to make good service possible. In a service so vital to modern cities, it would be difficult to overemphasize the importance of these demands.

NEVER SIMPLE, the task of administering water service has been beset by unusual difficulties during the past few desolate years. Operating budgets have been reduced to shadows. Water department revenues have been raided for the support of general government operations. Routine maintenance, to say nothing of normal system extension, has been given but scant respect. And, of course, long-planned programs of system development have been all but forgotten.

Despite these tremendous handicaps, waterworks administrators during the last few years have managed to make remarkable progress in cultivating the systems entrusted to them. In large measure this has been made possible by the compelling and essential nature of water service and by the fact that waterworks improvement is highly productive of employment. In consequence, a number of underdeveloped water systems have been advanced to where they can now perform the service expected of them, and the improvement of existing facilities has been a frequent subject of unemployment-relief enterprises. Highly gratifying though these achievements are, they merely serve to exemplify that the typical city has never caught up with the fair and reasonable demands made upon it for water service.

WHAT LIES AHEAD is more important than past accomplishments, however. The water engineer's problem lies largely in the future, for water service can never be static. Thus in the widespread drought of three years ago the danger that lies in narrow supply margins were revealed; and already a new drought is on the horizon. Planning of water systems cannot give full assurance unless it looks ahead with broad vision to appraise coming contingencies. Cities grow even while stock markets decline, and water consumption more than succeeds in keeping pace. There are evidences everywhere today that rates of draft are approaching the curves projected for them before the advent of our economic ills. Parsimony may cause a water shortage.

Not only does demand constantly increase, but the quality of sources has in most cases a tendency to decrease, particularly when they are situated near our large cities. For example, no longer can the waters of the Great Lakes be used safely without purification. Of the two large Lake cities still lacking filtration, Milwaukee is now building a plant and Chicago has one definitely projected.

THE FUTURE OF WATER SERVICE depends even more greatly on sound financial administration than on technical details. Here the teachings of the depression are particularly clear. Even where independence of water finances from the general finances of local government was thought to be assured, the water funds did not always remain inviolate, for water revenues have a tempting appearance to city fathers when taxpayers grow excited. Inviolable financial independence is imperative if planning is to avoid such pitfalls.

An integral part of the fiscal problem is that of compensatory rates and equitable rate structures. Much progress remains to be made in rate practice as well as in the accounting on which it rests. Metering and sound rate systems are basic items of future advance.

LOOKING AHEAD, then, it is plain that the water supply art is called to go forward with new vision and determination into tasks made more definite by depression experience. Three objectives are seen to be primary: *first,* continuous maintenance of systems at maximum operating efficiency and economy; *second,* farsighted planning for the future, both as to physical facilities and financial resources; *lastly,* progress toward organizational reform which through administrative and fiscal autonomy will assure the continuity of adequate water service beyond peradventure. It is the hope that the following pages may prove helpful toward the realization of these objectives.

IMPROVING WATER SERVICE DURING THE DEPRESSION

A RECOUNTING of the means taken by a number of cities during the past few years to improve the economy and operating efficiencies of their water systems

FACED WITH the urgent need for greater economies and increased revenue, many water departments during the past year or so have worked valiantly to improve the operating efficiencies of the facilities in their charge. Among the means widely employed to this end were waste-reduction programs, distribution-system improvements, better purification methods, and modernization of records systems.

Typically, large-scale improvements or extensions have not been undertaken, largely because of the municipal financial difficulties that have characterized the recent past. The situation thus presented, however, gave opportunities of two kinds to progressive waterworks departments.

In the first place, the normal engineering forces were able to devote their time and energy to many service-improvement projects that had long been held in abeyance; and second, the need for providing work for the unemployed made available a large amount of labor which, so far as the water department was concerned, could be had for the asking.

In most cases the utilization of relief labor has been the most important element in the service-improvement programs. Although special problems were thereby introduced, such as the encouragement of as much hand-labor work as possible and the discouragement of projects involving the use of large quantities of material, the consequences of these programs have been in most cases wholly admirable. For example, New York City has materially reduced the amount of water wasted through the location and repairing of leaks in the distribution system; Philadelphia has made a complete condition survey of gate valves, reconditioning them where necessary; Richmond has made many improvements in its filtration plant; Buffalo has greatly extended the high-pressure system in the downtown area; and Pittsburgh has repaired damage done to steel pipes by electrolysis and protected them from further corrosion.

The following statements, when so designated, have been prepared by the operating heads of the water system discussed. Other information has been obtained by field inspection or has been made available by those in charge of the water utilities.

Among those who assisted us in compiling information on this subject were Chas. M. Reppert, chief engineer, department of public works, and C. F. Brown, construction engineer, bureau of water, Pittsburgh, Pa.; Allan D. Drake, director of water, Buffalo, N. Y.; Jos. W. Ellms, engineer of water purification, Cleveland, Ohio; Loran D. Gayton, city engineer, Chicago, Ill.; C. W. Wright, assistant civil engineer, Detroit, Mich.; J. A. Jensen, supervisor of water department, Minneapolis, Minn.; and E. E. Wall, director of public utilities, St. Louis, Mo.

NEW YORK REDUCES WASTE BY STOPPING UNDERGROUND LEAKS

By William W. Brush
Chief Engineer,
Dept. of Water Supply, Gas and Electricity,
New York City

PRIOR TO 1931 the capital improvement work carried on by New York's Bureau of Water Supply generally required the annual expenditure of about $5,000,000. Toward the end of 1931, the market for municipal bonds vanished, and capital expenditures were limited to completion of current contracts. Contracts for construction work chargeable to capital-outlay account awarded in 1931 amounted to $4,590,620, in 1932 to $87,404, and in 1933 nothing. These figures are exclusive of expenditures made for maintenance account. As virtually all of the New York water-supply construction is normally carried out under contracts, the bureau only had the design and supervisory force of some 200 employees in addition to the regular maintenance and operating force of over 2,000. None of these employees were laid off and all have been usefully employed.

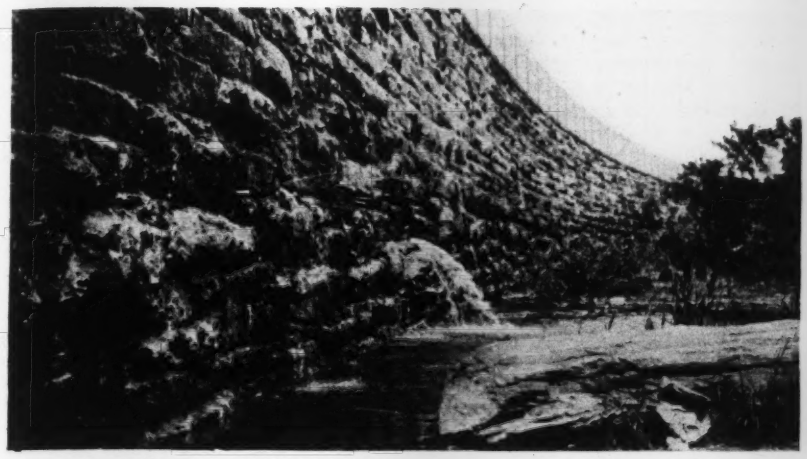
The work, which had been planned for the immediate future and which could not be undertaken until corporate stock funds were secured, was carried forward as far as possible by completing detailed surveys for steel pipe-line geometry, preparation of contract drawings and contract schedules and specifications. The amount of work thus provided for has an estimated cost of $3,806,000.

Projects for new work with an estimated cost of $3,140,000 have been prepared for submission to the state PWA engineer; and while funds have not actually been allowed, the contracts for fourteen projects at an estimated cost of $1,804,000 have been prepared in contract form.

When many construction contracts were under way, there was insufficient force to permit of comprehensive surveys of distribution systems. The lull in the contract construction work made it possible to carry on systematic and most comprehensive distribution-survey work, involving hydrant flow tests in both the municipal system and private water company systems within the city limits. These tests were supplemented by trunk main pitometer surveys. The results obtained are now being studied as the basis for a comprehensive plan for replacing mains and installing new mains, to give adequate fire protection and domestic service. In the private water company areas department orders are issued for the necessary improvements which are predicated on these tests.

Stopping underground leaks

The bureau in 1911 had established a separate organization to locate hidden leaks in the boroughs of Manhattan and the Bronx where rock fills under many streets made it possible for large leaks to exist without any surface indications. For the five years ending in 1930 the average number of leaks thus located yearly was 123 and the total yearly average of leakage stopped was 10½ m.g.d. This work was accomplished by four labor gangs with engineers to perform and direct the leak location work. It was mainly done by aquaphone. The leaks located were those which had caused complaint either from property



LEAKS THROUGH THE WALL of Jerome Park Reservoir, New York City, which were stopped as part of the program to reduce water waste.

SERVICE-PIPE LEAKAGE such as was located by New York's aquaphone tests. These leaks were on two abandoned 1¼-in. service pipes. The leakage had apparently existed for many years.

ABANDONED service pipe that had been wasting great quantities of water.

owners or public service corporations, together with many causing no complaint that were frequently located in the search for the complaint leaks. If the repair companies could not readily locate the leak causing the complaint, the job was turned over to the special force. These leaks were therefore unusually difficult to discover. The yearly cost was about $42,500; and the estimated cost of each m.g. saved was $6.43, if we can assume that each leak would have continued to waste water for two years.

At the end of 1930 four more gangs were organized, with the necessary complement of engineers, and assigned to systematic aquaphone surveys of mains and services outside of buildings to locate leaks. The first survey consisted in listening on hydrants and valves and required 16 months to locate 209 leaks, totaling 33.8 m.g.d. The cost per million gallons saved was $2.22.

The second survey also covered the two boroughs and required 22 months to locate 471 leaks, totaling 54.9 m.g.d. The cost per million gallons saved was $2.36. In this survey the hydrants and valves were again used and in addition practically every other service was aquaphoned.

The third survey has now been under way for four months and 155 leaks have been discovered, totaling 14.8 m.g.d. This survey is including all services and special tests are made where services are unusually far apart.

For some four months past three additional gangs have been made up from the unemployed force of engineers and skilled and unskilled labor. These men are gradually being trained to effectively perform this work.

It is believed that when this survey is completed at the end of about three years the leakage underground may be reduced to approximately the amount that represents the economic limit for such underground surveys, but this determination can only be made when the present survey is finished. As new leaks are constantly developing, the survey for leaks must be virtually continuous.

During the past three years the complaint gangs have located and stopped 588 leaks totaling 33.3 m.g.d. The average cost per million gallons saved was $5.70. The total of all leaks located and stopped during these past three years reached the surprising large figure of 122 m.g.d.

Aquaphone surveys in the other three boroughs are being undertaken but are not expected to yield more than a small percentage of the Manhattan and Bronx totals.

New distribution maps

In the borough of Brooklyn some sixteen unemployed engineers and draftsmen have been engaged in preparing maps to a scale of 40 ft./in. to show all mains and services. These sheets are 27x40 in. and there have been 900 sheets finished; about the same number are still to be done. Other boroughs have carried on similar work.

Treatment of Catskill water

In 1926-27 and again in 1933-34 it has been necessary for a period of six months or more to treat the Catskill supply for turbidity. Heretofore, about a quarter of a grain of soda ash per gallon has been added at Ashokan reservoir headworks and a half grain of alum per gallon at Pleasantville. Sedimentation has taken place in Kensico reservoir, seventy-five miles from Ashokan and three miles from Pleasantville. The resultant cost of treatment has been about $2 per million gallons or $1,200 daily. To reduce this cost, hydrated lime has been added at Pleasantville as a substitute for the soda ash and some $250 has thereby been saved daily. The results indicate that the lime should be added just as the water enters Kensico reservoir, as a better floc can be obtained with the same amount of alum if the more acid water first reacts with the alum.

Laying water mains

With the stoppage of contract work it was necessary to organize pipelaying gangs from the unemployed forces. Inspectors of pipelaying and engineering assistants were assigned to direct these gangs and generally proved competent. In this manner the bureau has been able to lay mains to supply new buildings, to replace some of the old mains where greater capacity was needed and to lay some mains to strengthen the entire system.

The mains laid with appurtenances during the past two years are as follows:

Year	Linear Feet of Mains Laid	Valves Set	Hydrants Set
1932	206,917	1,750	764
1933	182,461	1,490	836

The unemployed force utilized by the department has usually been below 2,000 men and averaged 1,438 during 1933. Of this number 62 have been engineers and assistants, 37 clerks, 172 skilled workmen and 1,167 unskilled laborers. This force, in addition to laying water mains, has been engaged in repairing and painting buildings and fences, building walls and grading pipe yards and other property, replacing hydrants, cleaning up watershed lands, installing hydrant drains and many other miscellaneous items of work connected with a large water supply system. It is planned to clean and recoat some of the large steel water mains that have been in use for twenty years or longer, but the requirements of the distribution service have made it necessary to temporarily

postpone this work. The regular force has not been kept up to its normal size as men who have died or left the service have generally not been replaced, the reduction in force in the past two years amounting to 70 employees. Without the unemployed force the bureau could not now satisfactorily carry on its work even if the new construction work were to be stopped.

GENERAL IMPROVEMENTS MADE IN MANY WATER SYSTEMS

IN BUFFALO the most important work done in improving the facilities of the water department by using CWA forces is the extension of the high-pressure fire protection system in the downtown area.

This work was started in January, 1934, and to date there has been laid more than 10,000 ft. of 16-in. and 20-in. lines. Before these extensions were begun the high-pressure system consisted of six miles of pipe line and served an area of 387 acres. The plan is to augment this system by laying 10 miles more, which, when completed, will give high-pressure fire protection to a total of 900 acres.

As all of this work has been located in downtown streets which are congested underground with other utilities, it is by very nature a hand labor proposition. Universal pipe in 6-ft. lengths has been used because of its greater flexibility under the severe limitations of space for construction. It is estimated that the relief labor employed has worked with an efficiency of about 70 per cent of what would have been obtained by an average contracting organization.

In addition to the high-pressure system extension, the water department is revising its distribution sytem records by transferring block and pipe line layouts from maps to a system of 12x8-in. cards.

Detroit used CWA forces

Previous to the depression, Detroit was constantly improving its pumping and filtration facilities, replacing small mains with large, adding to the transmission system, building elevated storage tanks, increasing and improving office facilities, watching underground leakage and constantly maintaining the plant in all its branches.

Soon after the first of 1932 these activities were stopped wherever possible but under CWA a mile of 30-in. pipe was laid in the low service area; a few 4-in. mains were replaced with 6-in. or 8-in.; some paving was done in Water Works Park grounds; conduits for a private telephone system in Water Works Park were laid, and considerable painting was done on both the interior and exterior of buildings.

Previous to 1932, the organization had numerous departments and bureaus with their various heads. In the reduction of forces many of these heads were laid off and the various groups consolidated where possible, so that the duties of the remaining members of the force are now general rather than specialized.

Cleveland repairs filters

Increased inefficiency and general improvement of the waterworks of Cleveland during 1933 consisted chiefly of the extension of its distribution system in the metropolitan area, the building of a filtered water storage reservoir, repair of filter tanks at one plant, landscaping grounds at the other one and hunting cross connections.

Late in 1933 contracts totaling $2,613,000 were let for 36 miles of 16 to 48-in. pipe. All over 30 in. in diameter was of electrically welded steel, the remainder was of cast iron. A 30-per cent PWA grant was obtained.

In order to improve pressures on the West Side and adjoining suburbs a 23-m.g. reinforced concrete filtered-water storage reservoir was built at a cost of $386,000. It is 326 by 306 ft. in plan by 32 ft. deep to the flow line. The roof has a membrane waterproof coating protected with a layer of asphalt. Special provision for preventing leakage of surface water into the reservoir was made in the laying of the waterproofing at the concrete expansion joints. Over the asphalt waterproofing was placed a 3-in. layer of crushed stone for drainage purposes. Between the crushed rock and the waterproofing was placed a layer of asphalt planking to protect the waterproofing, and over the rock was laid a 1.9-ft. fill of soil.

Extensive repairs of filter tanks at the Division Filtration Plant have been under way for nearly a year. Waterproofing of the interior of these tanks, after cutting out damaged and inferior concrete, has been done with layers of asphalt and impregnated fabric. Asphalt planking has been placed on the vertical sides to a depth equal to the combined thickness of the gravel and sand layers. Some slight modifications of the pipe strainer system and collecting pipes have been required. Rebuilding of the filters has enabled the gravel to be regraded and the sand to be removed and thoroughly cleaned by using a new sand cleaner of an efficient type. This work

RELIEF WORKERS IN BUFFALO were employed to extend the high-pressure system in downtown district.

is being paid for out of revenues of the department.

The landscaping of the grounds around the Baldwin filtration plant was actively prosecuted, being financed by the department except for a small amount of CWA labor.

An investigation still under way consists of a survey of fire service and industrial cross-connections in the distribution system. This work was undertaken to reduce or entirely eliminate the sanitary hazard involved in cross connections between the city's water supply lines and any polluted secondary supplies.

Minneapolis hunts waste

An underground leakage survey is now being made in Minneapolis. The work is being done by pitometer, under contract. It is calculated that the net revenue water accounts for 72 per cent of the total pumped. Of the remainder, 10 per cent is the estimated public and free use, leaving 18 per cent unaccounted for. It is to cut the 18 per cent that the survey is made. This is on a guaranteed basis, the work to remain within a certain cost limit.

Two additional coagulation basins having normal 3.3-hours detention periods are being built by force account at the Fridley filtration plant at a cost of $225,000. The basins are arranged for straight-across flow with guide baffles instead of the usual division baffles with round-the-end flow. Velocity will be reduced to a minimum of 2 ft. per min. Additional capacity, much needed, and a better effluent are expected.

Chicago makes leak survey

Cooperating with the CWA, the water pipe extension division of the Chicago bureau of engineering during the last year dug up, repaired and adjusted 23,388 shut-off valves. Inspections for leakage were made on 359,148 premises, where 653,615 fixture leaks were found and 35,000 repaired, stopping a waste estimated at 13.4 m.g.d. It is estimated that 200 m.g.d. is the total wastage of the whole system. Some 620 small antiquated fire hydrants were replaced with modern 4½-in. nozzle fire hydrants. Nearly 2,000 meters were relocated, 14,400 meters were surveyed and 8,000 were recommended to be replaced by others to register the consumption more accurately. About 13,650 valve and fire cistern basins were cleaned and 977 joints in 2 miles of 36-in. feeder mains were overhauled. The CWA paid for all labor. The cost of material was borne half by the CWA and half by the city.

St. Louis reduces purification costs

A number of changes and additions costing $30,000 have recently been made at the Howard Bend filter plant of the St. Louis water works on the Missouri River. The river channel above the intake has been cleared to give a free flow of the river against the intake gates. The mixing chamber, which had been operated under pressure since the plant was started, was found to be practically clogged with sediment. It was opened and changed into a gravity flow chamber. A new 5,000-ton coal storage bin was built. One-half mile of 12 to 21-in. sewer was laid for draining the lower area south of the basin.

The most important work of the year was the survey, preparation of plans and specifications, and obtaining of right of way for 13 miles of 60, 54 and 48-in. steel pipe line connecting Stacy Park Reservoir and the distribution system in south St. Louis at Grand Ave. Contract for the pipe was awarded Mar. 16 for $676,277.20, and for the laying for $336,402.75. These figures are exclusive of right-of-way and pressure reducing valves. A PWA 30-per cent grant has been obtained. Other additions to the distribution system involve 12 miles of 6 to 36-in. pipe at a cost of $225,000.

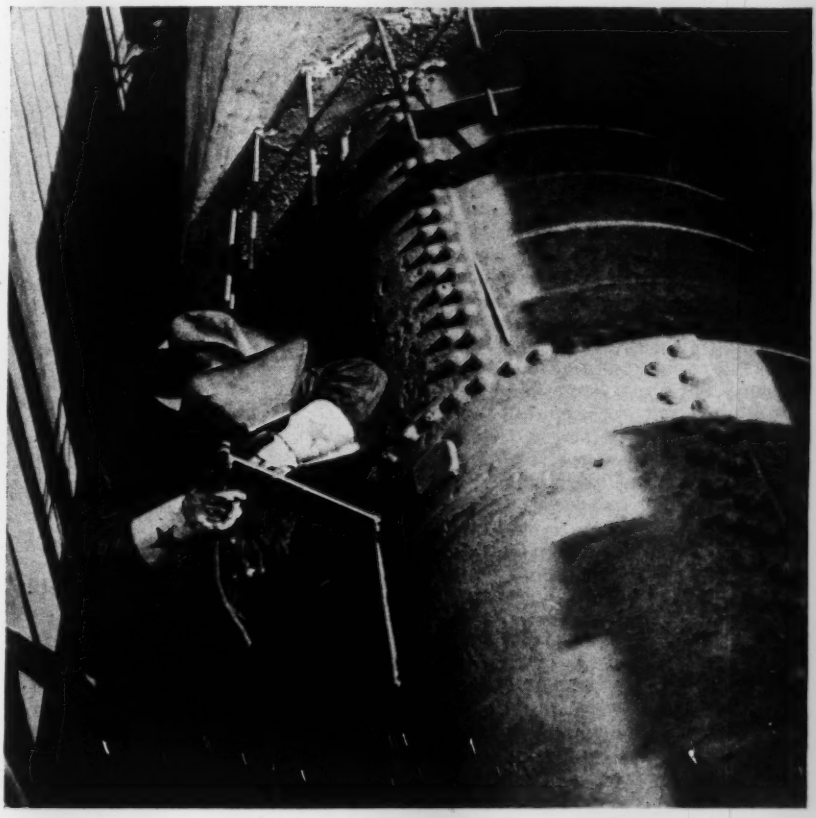
Studies and investigations are in progress with a view toward improvement in purification methods and a reduction in chemical costs. The reduction in the cost of operation has not in any way interfered with the efficiency of the service rendered the public.

WATER-DISTRIBUTION SYSTEM STRENGTHENED AT PITTSBURGH

WITHIN quite recent months the Pittsburgh bureau of water has undertaken an extensive program of system improvement with the aid of workmen provided by the CWA and its successor relief organization.

This program includes the replacement of about 15 miles of old and now inadequate distribution mains, the repair and encasement of sections of three large steel feeder mains, the construction of an additional supply main to one of the secondary pumping stations, now dependent on a single supply main, and

CORROSION OF STEEL PIPE by electrolysis and soil action is being repaired in Pittsburgh by welding on steel patches. The pipe is being protected by being encased in 12 in. of reinforced concrete. In this illustration the welding current has been cut off.



the construction of a small high-pressure water main connecting two pumping stations. None of these projects has yet been carried to completion, but they have given employment to a large number of men and when finished will be of great value to the supply system.

One project involves the replacement of inadequate water mains, varying in size from 4 in. to 12 in., in 78 different locations and aggregating about 50 miles in length. When completed, this project will take care of about 12 per cent of the need for immediate replacement of dangerously inadequate distribution mains which now represent a hazard because of the limited capacity for fire protection purposes. This project was about 16 per cent completed as of April 1.

Another job consists of the construction of 3,100 ft. of 30-in. cast-iron pipe through city streets to provide an additional source of supply for the Mission St. pumping station, which serves a district having a population of about 40,000. This district is situated on high ground on the south side where no reservoir sites are available and where storage capacity, therefore, must be limited to relatively small tanks. Hence the continuity of water supply to this large area is now dependent upon the uninterrupted operation of the pumping station, which in turn is dependent upon supply through a steel line 6 miles long (including a river crossing), now 30 years old and known to be in dangerous condition in several locations. This project also was about 60 per cent completed on April 1.

A supplementary high-pressure service line is being built between the Aspinwall and the Ross pumping stations. The new line will reinforce the present facilities in which, because of the growth of the district served, use and operation factors are now subject to interruption.

At three locations large steel pipe lines which had been badly damaged by electrolysis or soil corrosion are being repaired by patching with steel plates, and protected from further disintegration by encasement in 12 in. of reinforced concrete. In all of these locations highly important large steel lines are involved, and duplicate or supplementary lines are absent. Due to age, electrolysis or soil corrosion, pitting has progressed to such an extent as to weaken the metal seriously, and at locations where work is now under way many minor breaks have occurred in the past. Any large break would cause considerable damage because of the size of the line and the high pressure. It would require possibly a week to repair such a break, and the resultant curtailment of water supply would involve a great fire hazard.

Considering the limitations imposed by an almost complete replacement of mechanical equipment with hand labor, the inexperience particularly of the common labor with this type of work, and the extraordinarily severe winter, the work has progressed without serious difficulty. The skilled and semi-skilled labor employed has been of a good type and soon became proficient in the work to be done. The character of the completed work is at least equal to work of the same kind done by the average contractor.

PLANT CAPACITY RAISED BY BETTERING OPERATION

By Marsden C. Smith

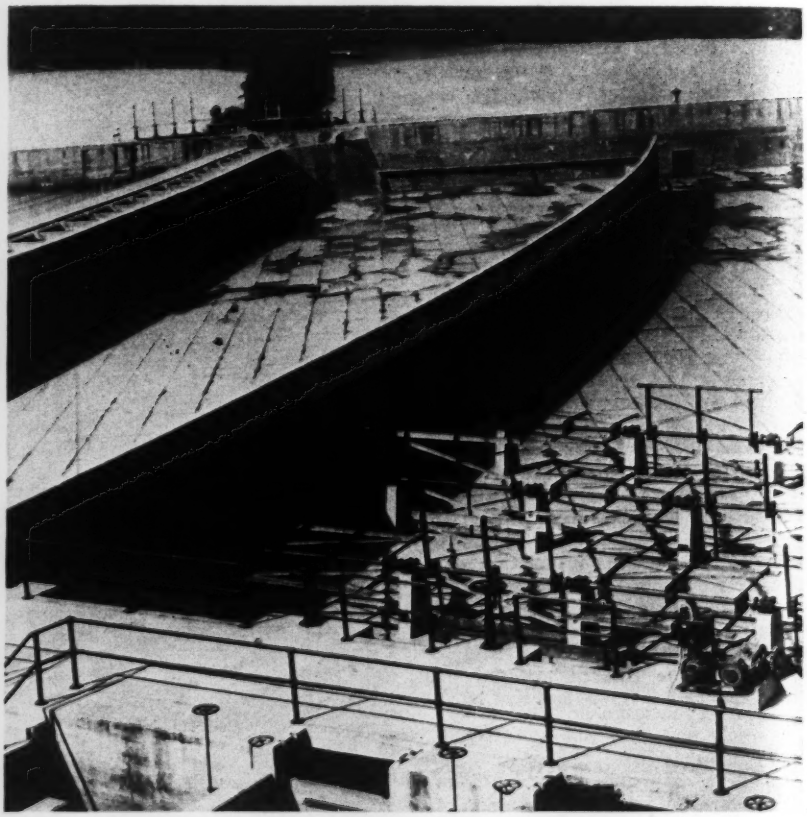
Engineer, Water and Electricity, Dept. of Public Utilities, Richmond, Va.

DURING the past few years improvements in the method of preparing water for filtration at Richmond, Va., have permitted the effective capacity of the plant to be increased by at least 50 per cent, and in addition have produced a vastly better effluent at a reduced cost.

To begin with, a low-lift raw water pump was installed to maintain an adequate operating head during the period of low water. A diversion dam, 700 ft. long, was built to increase the available head and to minimize the use of electric power for low-lift pumping. A new type of mechanical mixer was developed and installed, which is now coming into use in other parts of the country and is known as a "flocculator." A hoist and a monorail system was installed at the filter plant to permit the use of 1-ton containers of chlorine. With this system only one man is now required to handle the chlorine containers.

An open, low-depth, filtered water basin was eliminated. A reserve supply of washwater was made available. To facilitate operation, equipment has been installed to make possible the remote control of water levels from the filter operator's desk.

In addition to these improvements in plant, modifications have been made in the method of chemical treatment to yield better results. Instead of seasonal treatment of the raw-water settling basin to control algae, continuous treatment for that purpose has been instituted. To improve coagulation, the control of pH of the raw water has been undertaken by the addition of either



MECHANICAL MIXING EQUIPMENT installed in the Richmond filtration plant, which added materially to the efficiency of coagulation.

TABULATION SHOWING INCREASED EFFICIENCY OF PURIFICATION

	Alum, Lb. Per M.G.	P.P.M. Turbidity	P.P.M. Color	Residual P.P.M. Alumina	% Wash Water
Sept. 1930	816.5	1.50 F	7.3 F	.80 F	2.03
Sept. 1933	399.7	1.13 C	9.3 C	.48 C	.74
Oct. 1930	905.1	.50 F	4.6 F	.27 F	1.17
Oct. 1933	369.0	.50 C	6.3 C	.53 C	.95

"F" is after filtration.
"C" is coagulated and settled but not filtered.

lime or acid just prior to the dosing with coagulant. Taste-and-odor control has been adopted by the use of activated carbon fed in batch at the beginning of a filter run directly on to the filters.

In the chlorination of filtered water, the use of ammonia and chlorine in combination has ben adopted instead of the use of chlorine alone. To reduce corrosion, the final pH is now being corrected by a combination of aeration and chemical treatment.

Added to these, and of great importance, is the reduction that has been brought about in the pollution of the raw water supply by industrial wastes.

All of these improvements have been made since 1930 and the net effect can perhaps be stated best in the accompanying table of average results. This compares certain operating results for the months of September and October, always the most difficult months of the year. The years 1930 and 1933 are used because they indicate conditions before and after the improvements were made.

RELIEF LABOR UTILIZED TO RECONDITION WATER SYSTEM

By S. M. Van Loan
Deputy Chief, Bureau of Water, Philadelphia, Pa.

NO REQUESTS have been made by Philadelphia for funds from the PWA, nor had any plans been submitted for public works projects to the earlier RFC. However, under the CWA a number of waterworks improvement projects were undertaken to which several hundred men were assigned in December, 1933, and January, 1934. This force continued to be employed until the end of March, 1934, upon which date all CWA activities were absorbed by the LWD (Local Works Division) with a reduced number of laborers engaged.

The water - distribution system throughout the city is regulated by 49,500 gate valves. The normal force of the bureau of water is unable to cover the inspection of this equipment, in consequence of which a field engineer from the CWA with a group of laborers was assigned to operate and report condition of valves. Specific areas were outlined and attention was directed first to the older and congested sections of the city. Where the nature of the valve or the enclosing box was such as to require reconditioning, the information was relayed to the office of the superintendent of distribution where the work on repairs was scheduled for accomplishment.

In addition to the work on valves, many fire hydrants were painted. The painting annually of fire hydrants is desirable, but due to the reduced number of employees during the last two years such painting has been partially neglected. Paint and brushes were provided from CWA funds and specific areas throughout the city were allotted to the assigned group of laborers.

Great improvements were made in the method of keeping records of the distribution system. The early records of the bureau showing mains, valves and hydrants were noted on a standard form so ruled as to represent block or intersection location. During late years standard cards were selected to outline the history of work. All valves and hydrants will be described on an individual card and to accomplish a complete record for the bureau there were assigned draftsmen for transcribing from bulky volumes to the card system.

Repair of a special class of leaks occupied a significant place in the improvement program. The early construction of 48-in. cast-iron express mains followed unopened city streets through undeveloped areas. Grades, in some cases, had not been determined; hollows were bridged by wooden trestles and high elevations were negotiated by deep cuts. Subsequently the low elevations were opened for grading. Unintentional neglect at times prevailed as material was deposited in low territory and locations existed where grades were readjusted. Attention to leaks on these mains was frequently postponed on account of pressure of routine duties, and as the flow from leakage passed to natural channels the escape of water caused no property damage.

A field engineer from the CWA with a generous group of laborers was assigned to uncover the offending joints and stop the leakage, which in some cases was of large volume. Adverse weather conditions prevailed during the winter period of excavation and abnormally low temperatures were registered, creating discomfort for the force engaged and tightening the ground structure to the consistency of hardpan.

A great amount of demolition was also undertaken during recent years. Three of the major pumping stations formerly steam operated have been changed to electric, the power being under contract from and furnished by a local generating company. This transition has made useless such structures at pumping stations as smoke stacks, boilerhouses and steam auxiliaries, coal and ash handling towers and coal storage structures, and their removal was desirable.

This demolition involved brick and tile in cement mortar, reinforced concrete, structural iron assemblies and woodwork. Progress on these projects was slow due to restricted areas for activities, the severity of weather and the hazardous character of the razing and removal.

Relief labor was also utilized to advantage in reconditioning the filter plant equipment. The normal force assigned to the various filter plants is occupied by routine operating duties and expediency demands for plant service a minimum period of five working days per week. City finances for three years have reduced the allotment of funds to the bureau and a 4½-day week for per-diem employees has been made obligatory. This curtailment of labor has created an excess of essential work, a clearing up of which is vital to the ultimate operation of the filters. Also the advisable restoration of plant equipment and necessary improvements have been postponed to a situation approaching neglect. At the filter stations were assigned from the CWA a foreman and a number of laborers for constructive assistance in the cleaning of sand and gravel of the beds. Attention was also given to minor repairs to masonry and painting of woodwork.

The bureau owns extensive lands in outlying sections of the city, and activities were directed towards the clearing of trees and underbrush on these undeveloped areas. The labor was also assigned to work on embankment slopes and in the bureau storeyard, where rearrangement of pipe, fittings, valves and appurtenances was desirable.

The bureau has benefited through the efforts of the CWA force and the majority of appointments have been hard-working conscientious workmen. These men for outside work began their duties during the month of December, 1933, and the low temperature and the accompanying snow checked real progress in all outdoor projects. It is hoped that funds will be sufficient to carry on to such a stage that the work will in no way appear as a scar upon the existing works.

BUILDING A NEW WATER SUPPLY UNDER PWA AUSPICES

A HISTORICAL ACCOUNT of the difficulties overcome in carrying through to completion the force-account construction of an 11-mile pipe line to bring water to Shippensburg, Pa., the first PWA project in that state

By Farley Gannett
Consulting Engineer
Gannett, Seelye & Fleming
Harrisburg, Pa.

THIS is the story of the first PWA project to be built in Pennsylvania, an 11-mile pipe line for Shippensburg. It was conceived in December, 1932, was an RFC prospect in the spring of 1933, a PWA application in the summer and fall of 1933 and a completed intake and pipe line in the winter of 1934. During that period of sixteen months, three months were occupied in investigation, surveys and designs, nine months in negotiation and waiting, and four months in construction.

The application of the Borough of Shippensburg, Pa., for funds with which to build an 11-mile pipe line for a new water supply pioneered the way through the difficulties and personalities which naturally beset the earlier applicants to the RFC and the PWA. All one had to do to bring a smile to the countenance of a dignified official in Harrisburg or in Washington was to say, "Please, Colonel, how do I find out what has happened to the Borough of Shippensburg's application for funds with which to build its new water-pipe line? It is known, Colonel, as PWA Docket No. 1 for Pennsylvania; formerly RFC Docket No. 1 for Pennsylvania, and now it is PWA U. S. docket No. 740. It is apparently lost. Can somebody please try to find it?" Eventually, it was found, and the town received the federal approval and a promise of a grant.

The following account has been taken from the records of the ultimately successful attempt of Shippensburg, which lies snugly in the bosom of the beautiful Cumberland Valley of southeastern Pennsylvania, to get a much-needed addition to its water supply for its citizens and industries. For years this town of 7,500 population had been obtaining its water supply, in wet weather, from what is known as the "South Mountain," some four or five miles distant; and in dry weather, by pumping from a limestone spring, which was too hard for a satisfactory supply and also subject to pollution. The new supply discussed in this story is taken from the "North Mountain," about 11 miles away, where several large streams, originating in a thinly inhabited region will furnish an adequate supply (through a 12-in. cement-lined cast-iron pipe) for an almost indefinite period.

The undertaking had its inception on December 6, 1932, when notice was received from the office of the Burgess of Shippensburg, requesting our firm to make the necessary engineering studies and recommendations in connection with the proposed new water supply. At that time the Burgess suggested: "We are anxious that your investigation be completed as speedily as possible—but not without allowing yourself sufficient time for careful study of the situation."

First report made

Surveys were started the following day, and on March 15, 1933, the report, plans and recommendations were submitted. On April 10 a conference was arranged with officials of the RFC in Washington (there was no PWA at that time) to determine informally whether or not money could be obtained from that organization for the construction, amounting to $130,000. The result of that conference was favorable, and the necessary forms were obtained upon which to present the application. These forms, comprising some 25 or 30 pages, were filled out by the engineers and the legal advisers of the town, and were filed in Washington on May 4.

In the meantime, however, it was necessary to get the approval of the state department of health for the use of this source of supply, and application was made, accompanied by the necessary plans, report and recommendations. State inspectors were shown over the ground, and approval was received on August 10.

The matter of authorizing $130,000 of bonds to finance the project was put up to the voters on June 28 and was passed by a large majority.

During June press dispatches from Washington announced the decision of the President to create a new public-works organization with a war chest of three billion dollars to stimulate heavy construction work, including federal, state and municipal public works of all kinds, and shortly after the middle of June this suggestion became a law. An organization was promptly set up in Washington, which was shortly to become nation-wide in its activities.

Dealing with the new-born PWA

Immediately following the receipt of this information, I went to Washington to interview the new Public Works Administration, of which Colonel Sawyer was then in charge. It was found that the U. S. Geological Survey was moving out and the PWA moving into the better part of a floor in the Interior Department Building, and everything was in a state of disruption. It was impossible to see Colonel Sawyer, but his secretary, who had been with the organization since its formation a few days before and who knew the ropes, told us all he had learned in those few days. This consisted largely of the fact that under certain conditions, loans would be made at 4 per cent, and a 30 per cent grant would be given to worthy projects; that the application blanks weren't yet printed; that state or district organizations would be set up, and that applications would have to go through them; that Washington wasn't going to bother so much with detail as it had with RFC matters, and that the PWA was going to take over all the RFC applications for public works.

We withdrew the RFC application which we had laboriously prepared and decided to go to the PWA for the money, but we couldn't go to the PWA immediately because there wasn't anybody to go to. It was decided, however, to go ahead with the preparation of detailed plans and to await eventualities and the completion of the organization of the PWA.

Pipe purchased for the job

We prepared the working plans and specifications, staked out the line and took bids for the pipe, asking for alternative bids on welded steel pipe lined with bitumastic enamel, and cast-iron pipe lined with either enamel or cement. These bids were received on July 24, 1933. Cast-iron pipe, lined with cement and finished with a bitumastic priming coat on the cement, was decided upon. The price was very low because competition was keen between steel and cast iron and there was, as yet, no NRA price regulation. Many thousands of

dollars were saved by advertising for pipe bids early instead of waiting final approval by the PWA before taking this step.

State PWA organization established

Washington, in the meantime, was trying to decide as to how the various state or district organizations would be set up for the PWA. It was finally decided to have a board in each state, appointed by the President, with an engineering staff under each state board, so that the organization would be decentralized and the piling up of work in Washington prevented. Further inquiries at Washington elicited the information that state engineers would be appointed as soon as the President returned from his summer vacation, and it was intimated that once we obtained the approval of the state board, the project would have clear sailing and the money would be forthcoming. The great day finally arrived in the latter part of August, and our Pennsylvania engineer and board was announced. Major Gastrock, as executive secretary, was first to arrive; then Colonel Trees, chairman; Major William Gravell, chief engineer; Colonel Wickersham, assistant engineer, etc. They were to occupy some temporarily vacant rooms in the state capitol and our Shippensburg project was there to welcome them. The plans were put before them before they had their coats off, and we were given blanks to fill out. This we did, but in a day or two came new blanks, many pages long instead of two pages (Washington was getting busy), and we filled them out. Not as bad as the RFC blanks, but doing very well!

The application went from Harrisburg to Washington on Sept. 1 in such a hurry that full instructions, forms and regulations governing the Harrisburg PWA office were not yet at hand.

In the meantime, however, the award of the contract for the pipe was made, and soon thereafter its manufacture was begun. It was possible to make this commitment because the town was assured of the possibility of selling its bonds and of doing the work itself if the PWA refused. It was feared that if contracts had to be advertised and bids taken, etc., there would be six weeks more delay in getting construction under way, so the town decided to ask the PWA for permission to employ Gannett, Seelye & Fleming as its agents in building the line.

About the same time we received word from the PWA office in Harrisburg that a general order had just come through, asking for more detail with regard to the estimates of cost, breaking them up as between labor and materials; setting forth the number of man-hours that would be required to complete the job, and separating the items of engineering, legal expenses, real estate, rights-of-way and contractor's profit. This information was immediately furnished and sent to Washington, through the Harrisburg PWA office, on Sept. 23.

We learned that on old friend had recently been appointed to a position in the engineering division of the PWA at Washington and wrote him, asking him to please get behind this application as there were 200 men withheld from work pending the approval of the application; also that the pipe had been bought, the line staked out and everybody was waiting. This was followed up by a visit to Washington, and it seemed as if the application had been lost; but finally assurance was given that it had been found and that we might expect early action, as it was now being examined in the various departments of the PWA.

Announcement was made that all PWA jobs would pay 50c. an hour for labor, with a maximum of $15 a week. This resulted in a call from the officials of Shippensburg to discuss whether or not to go ahead with the work at all, because they were fearful that this high hourly rate would have a bad effect on employees who were working regularly in various establishments in the town.

The PWA gives its approval

Suddenly, out of a clear sky, notice came on Oct. 11 that the application of the Borough of Shippensburg requesting a loan and grant for $150,000 had been approved by Washington. We had only asked for $130,000. The approval did not state whether Shippensburg could build the job with its own forces or whether it had to advertise for bids, so an urgent request from the PWA engineer was sent to Washington a few days after we received notice of approval of the loan and grant. On Oct. 23 we were advised that we might go ahead with the construction of the work, without advertising for bids, and on Oct. 30 we started the actual construction.

The market for municipal bonds, which for months had hardly been salable at any price, had improved to such an extent that it was decided to try to sell the 4 per cent bonds to banks instead of trying to borrow on them from the United States. So the town advertised $100,000 of bonds and received a high bid of 102.5. We sold them and thus received a premium of $2,500 on the sale. Then the PWA was told not to worry about the loan as all we wanted was the grant.

The Federal Re-employment Service had been announced sometime previously, and the instructions were that all labor should be obtained through that organization, which was planning to have offices in each county, where the unemployed would be registered and from which registration lists the employees would have to be allotted to PWA jobs in that county. We therefore notified that organization of our expectation to start work on a certain date, and that we would need labor promptly. The town authorities had previously listed the unemployed in Shippensburg and found that there were over 400 men needing work in this little town of 7,500. They were clamorous over the delay in getting the pipe line started, as the town had voted 2 to 1 in favor of the bond issue, largely to give work to the needy. This vote had been taken in June, and although it was now October, the work had not yet been started.

Actual work is started

Work began on Oct. 30. We were not supplied with men from the Federal Re-employment Service, as the offices of that organization in Carlisle, the county seat of Cumberland County, had not been organized and no lists were available from which men might be drawn. We therefore naturally selected the men from the lists of unemployed prepared by the borough officials of Shippensburg, following the order of preference stipulated in the regulations of the PWA. A 30-hour week was adopted, and the men were worked in two shifts of five hours each, one starting at 7 in the morning and ending at noon and the second shift beginning at noon and ending at 5 p.m. This worked out very well, as many of the men were soft, and five hours was about all they could stand with a pick and shovel.

We had been working about a week when the Federal Re-employment Division called to know why we were not getting our men through them. They were told that the only reason we weren't was that they were not able to give us any, because they had no organization and no lists. When they were ready, we told them we would be glad to have them supply the labor—but it must be Shippensburg labor. It finally worked out that the labor was taken very largely from the town lists, and we filled this list, as men were added, with men from the Federal Re-employment Service.

After the job started, the contract with the United States for the grant was not signed, and the PWA told us to slow up until it was. On Dec. 5 the PWA approved a grant of $36,000 instead of both loan and grant of $150,000. Cold weather and wet weather set in in earnest and ran the costs up and slowed down progress. By February it was evident that the job would cost more than $130,000. Furthermore, the town instructed us to use no more machinery than was absolutely necessary so as to use more men. As we had based our costs on using trenching machines, this added further to the cost.

While in Washington one day, we called on the inspection department and found that a new way of figuring the grant had been decided upon. Formerly the engineering costs and contractor's profits were omitted, then 85 per cent

of the remainder was computed, and the grant was 30 per cent of that amount. It had since been changed, allowing engineering costs during construction, and contractor's profit and 101 per cent of that total. The grant was computed as 30 per cent of the resulting figure. This would make our grant $42,000 instead of $36,000. So we applied for an increased grant.

Auditors visited us twice during the progress of the job and checked our accounts, requested various and sundry affidavits, legal opinions, copies of highway permits, bank balances, etc. An engineer inspector was on the job daily, assigned to this job by the government. The field men, auditors and inspectors, knowing their business, were fair and reasonable and did not expect the impossible nor the impractical on the work.

On March 3 the job was finished, but the town had not yet received a cent of the grant.

The job had been started on Oct. 30, and we had actually worked 94½ days. The largest force working in one shift was 249 men. The total cost, including intake, valve house, chlorinator, valves, specials, etc., was $148,000.

We attached 35 new consumers as the line was laid through three small villages, and we also constructed 8,000 ft. of 6-in. line to the near-by village of Orrstown and built the distribution system in the town, which now buys water wholesale through a meter at the junction of the 6-in. line with the 12-in. main line.

A first payment (about $19,000) on the grant was made early in March, and the last payment, completing a total of $36,000, was made April 30, notwithstanding the fact that we had, months before, applied for a larger grant and had been assured that we would receive it. The actual cost of labor and materials was such that the 30 per cent grant should be approximately $42,000, and the auditor's report and the recommendation of the PWA engineer for Pennsylvania both agreed to that amount. Nevertheless, Washington sent but $36,000, and we are now going through the process of attempting to upset the decision of some official in Washington that $36,000 is all we should have.

Anyway, Shippensburg now has its new water supply!

BUILDING A FILTER PLANT FINANCED BY THE RFC

VILLAGE of Wilmette, Ill., by building a 6-m.g.d. waterworks with federal funds, averts threatened water famine and ends local controversy over new supply—To preserve view of Lake Michigan, plant is built low and provided with a promenade roof

WHILE the new 6-m.g.d. waterworks plant for Wilmette, Ill., is noteworthy because of the difficulties experienced in arranging for its financing as one of the first RFC projects, it also has several unusual features of design, and a large number of construction problems had to be overcome. Salient points of these phases of the project form the subject matter of this article.

Local opposition to the project, some of it political in nature, made financing with the RFC more than usually difficult. The site chosen for the plant was under a bluff facing Lake Michigan, and plant design was controlled largely by the necessity of preserving an open view of the lake from a club property across the street, which was antagonistic to the project. A plant built deep into the ground resulted, necessitating pumped drainage, provision against flotation and careful architectural treatment. The limited space available accounted for many of the construction problems that arose.

Much is published in engineering journals and society proceedings with reference to design and construction of public improvements, but little has been said about the way a project attains maturity. Usually, municipal water supply and sewerage undertakings require anywhere from one to twenty years to reach the point where plans can be prepared and bids received. On an average a municipal project of importance takes five years to mature.

At Wilmette, a Chicago suburb, the water supply has hitherto been purchased wholesale through a single connection with the system of the adjoining city of Evanston. The distribution system is owned and maintained by Wilmette. To maintain adequate pressure in the Wilmette system, it has been necessary to boost the pressure at the point where it is taken from Evanston. The connecting mains were not as adequate as they should be, and consequently at times of heavy draft it has been difficult for Wilmette to obtain enough water to meet heavy demands. For many years there has been occasional discussion with reference to the desirability of an independent waterworks for Wilmette, but it can hardly be said that the question was given serious consideration until the drought of the summer of 1930, when Wilmette was entirely without water at times, creating a serious fire hazard. This precipitated a pronounced popular sentiment for an independent water supply. In September of 1930, engineers were retained to advise as to the best general scheme for an independent water supply and to prepare estimates of cost so that a bond issue might be submitted to a referendum as required by law.

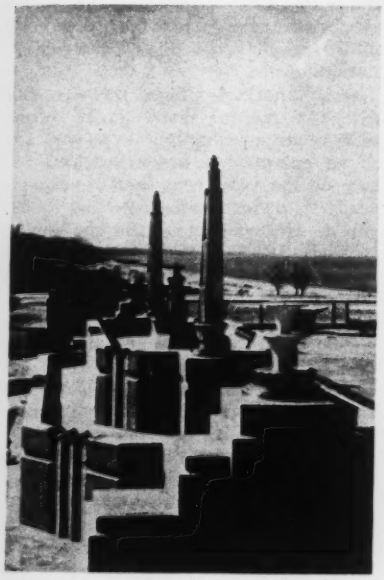


FIG. 1—ORNAMENTAL FOUNTAIN separating the two levels of the esplanade on the roof of the waterworks plant.

In connection with engineering studies, the conclusion was reached that the design should be based upon estimated requirements for twenty years, with an average daily consumption of 140 gal. per capita and with a maximum daily consumption of 300 gal. per capita.

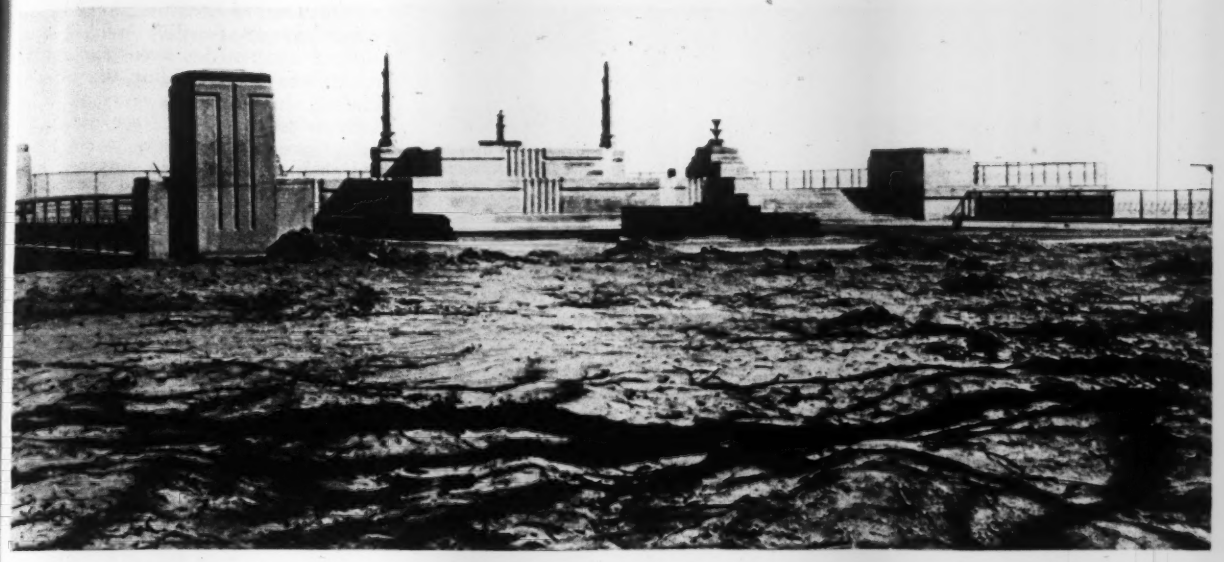


FIG. 2—FROM THE STREET all that can be seen of the plant is the promenade deck and ornamental fountain.

This called for a 6-m.g.d. filtration plant costing $700,000.

In the November, 1930, elections the public voted against an issue of direct-obligation bonds in this amount, but no intensive effort had been made to secure a favorable vote. Just prior to the time that the bond election was held, the effects of the depression had become acute, and there developed a strong sentiment against any enterprises that might result in added taxation.

The officials thereupon addressed themselves to the problem of improving connections with the Evanston waterworks system so as to obtain better service. This, combined with certain improvements and additions contemplated in the Evanston waterworks system, would have made it possible to secure an adequate supply. Suitable modifications and improvements were estimated to cost $100,000. Accordingly a bond election was called in April, 1931, for this amount and was voted upon favorably by a substantial majority.

Then the village administration changed. The new village president was of the opinion that it would be unwise to proceed with improved connections to the distribution system of Evanston until some negotiations had been carried out to obtain a more favorable rate of charge. The rate up to this time had been a step-down rate available to any large consumer and resulted in a return to Evanston of 7.1c. per 100 cu.ft., or 9.5c. per 1,000 gal.

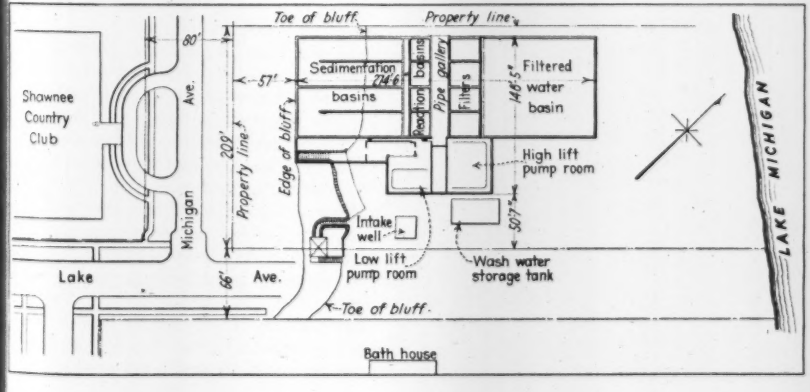
Careful estimates were made of Evanston's costs and of the cost of furnishing water by an independent plant. These estimates were based upon an assumed daily consumption of 115 gal. per capita applied to the expected population growth year by year. This is a lower figure than the per-capita consumption used as a basis of design and therefore in the interest of conservative financing. Over a period of years an independent plant, it was found, would allow a substantial saving, but attempted negotiations with Evanston for a lower rate were not successful. The new administration thereupon decided it would be desirable to build an independent plant. New state legislation had modified certain statutes relating to financing of waterworks, permitting the issuance of water-revenue bonds payable solely out of water revenues. With this type of financing contemplated, the village officials felt confident that public support could be obtained for an independent plant.

In August of 1931 the engineers prepared outline plans and brief specifications for an independent waterworks, to be financed by water-revenue bonds. A referendum was held on Dec. 5, 1931, three months after the enabling ordinance was passed, the earliest legitimate date. Prior to the referendum date a vigorous campaign was waged by the proponents and the opponents of the project. Notwithstanding much confusion of thought, the general public was persuaded that an independent plant was desirable and voted in its favor in the ratio of five to three, the total vote being a heavy one.

Bids were received on complete plans and specifications on April 5, 1932. At this stage of the depression most contractors were without jobs, but were still struggling to hold their organizations together and remain in business. There was an extraordinary number of bidders for a job of this magnitude; over 50 bids in all and 15 complete bids on all divisions. The combined low bids totaled $450,000, or about $50,000 less than the engineers' estimate.

At the same time that bids were asked on construction work, bids were also invited on the purchase of the bonds, but by this time the bond market had become greatly demoralized, and the situation was complicated by the tax muddle in Cook County. Although a number of investment bankers had pre-

FIG. 3—FILTER PLANT located at the foot of a bluff on Lake Michigan, directly across the street from a country club. The limited area available caused serious difficulty in construction.



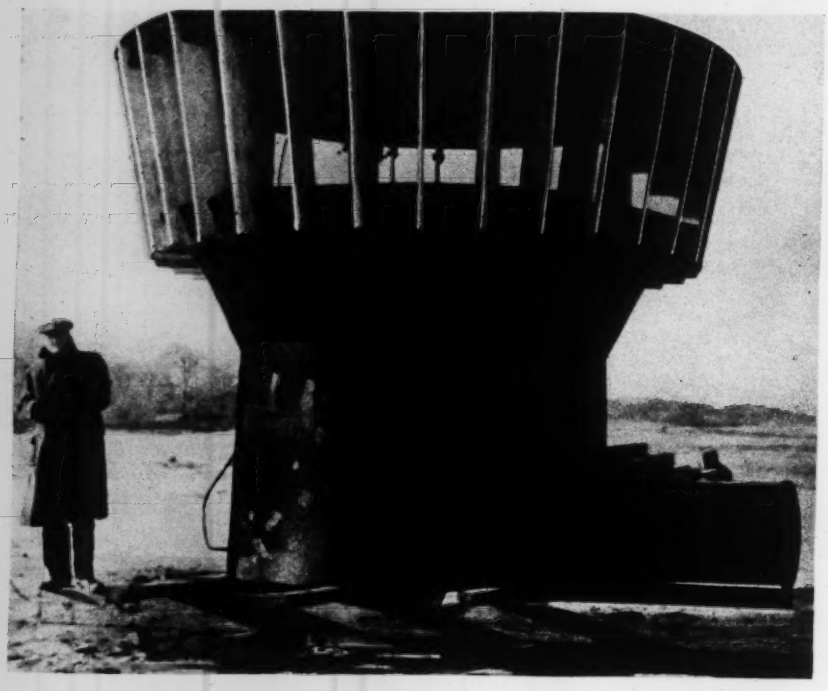


FIG. 4—INLET DRUM at end of intake pipe. It was installed 3,000 ft. out into the lake in 23 ft. of water. It is designed to minimize vortex action and the attendant ice troubles.

viously indicated a lively interest in the issue, no bids were received.

RFC enters picture

The construction bids were held with the consent of the bidders for over a month in the hope that some means might be found for disposing of the bonds, but without success. Meanwhile the RFC was set up to finance public works through the purchase of sound securities at a reasonable price.

On the day after the congressional enabling act went into effect on July 19, 1932, the village president made an application for the purchase of the revenue bond issue. Visits by the village president and the village attorneys were made to Washington in July and August to acquaint the officials of the RFC with the character of the issue. But until Sept. 1 the RFC had not formulated rules for making applications and in fact was not adequately organized to consider applications.

At about this time the famous RFC Circular 3 was issued, and an application was made out in accordance with it. Preparation of this application was a laborious and time-consuming effort. Notwithstanding the fact that the plans and specifications were fully completed and every legal step necessary had been taken, it took nearly three weeks to compile in satisfactory form the required information. The completed application was forwarded to RFC headquarters on Sept. 20, 1932. The village was invited to send a delegation to Washington for a hearing on Sept. 28, 1932. It was assumed that by the time of the hearing the material submitted in accordance with Circular 3 would have been fully examined, and that after an adjustment of details through conference the purchase of the securities would be authorized.

It soon developed, however, that the process of obtaining government aid was not quite so simple. It was necessary for at least one of the representatives to remain in Washington for a period of about ten days in order to follow through the application and supply such additional information as was required. There was much uncertainty on the part of the board of advisory engineers of the RFC as to whether the loan should be granted. This doubt was based partly on the protests of objectors to the project and partly on misgivings as to the general financial condition of the village. The matter was kept under advisement until Oct. 20, 1932, when an agreement was finally received for the sale of the securities to the RFC.

On Oct. 15 advertisements for new bids were issued, to be received on Nov. 15. Again there was a large number of bidders, though not quite so many as in April, and for the most part the bidders were contractors who had not submitted bids in April. The low-bid figure, $400,000, was now even lower than before.

Injunction invoked

On Nov. 21, 1932, six days after these bids were received, an injunction suit was filed by the Shawnee Country Club, which has an attractive building opposite the waterworks, seeking to restrain the village from building the plant on the site chosen. While every effort had been made to convince the public that the proposed waterworks would not be unsightly or constitute a nuisance in the neighborhood on account of smoke, fumes and noise, nevertheless it appeared that many members of the club were greatly disturbed because of their ideas regarding the character of a waterworks. Many people were laboring under the fixed belief that waterworks necessarily must be accompanied by tall chimneys, belching black smoke, extensive coal-handling operations, grimy boiler rooms and big cinder dumps.

As the club was not willing to file the bond required for a temporary injunction to prevent proceeding with construction, it was permissible to award contracts and place the work under construction. The first earth was turned on Feb. 20, 1933. Construction proceeded with reasonable rapidity, and on March 1, 1934, the plant was practically completed and had been placed in regular operation.

After the plant was completed and put into operation early in March, those who brought the injunction suit began to weaken, especially in view of the demonstrated fact that the plant is an ornament to the locality and that the electrically driven pumps do not cause either noise, odor or fumes. Finally in May the trustees withdrew the suit and amicable relations were resumed.

Design features

The lake-front site of the Wilmette waterworks is characterized by a wide flat sandy beach rising 4 or 5 ft. above lake level, and by a steep clay bluff that rises to the general street level. The top of the bluff is 20 ft. above the sandy beach and 25 or 26 ft. above lake level. The area from the street to the edge of the bluff is parked and attractively planted with trees and shrubs. The waterworks stands directly in front of the Shawnee Country Club, and the members regard the unobstructed lake-front and bathing beach as a special asset.

In deference to the club the engineers of the plant were instructed to build a roof that would not rise materially above the top of the lake bluff. The engineers were also instructed to design the roof of the plant as a deck to be used for observation and promenading. To make sure that the design adopted would harmonize with the attractive architecture of the club, Burnham Brothers, architects, who designed the Shawnee Clubhouse, were engaged as consulting architects to assist in the design of the architectural elements of the waterworks.

The necessity of keeping the roof deck substantially at the level of the top of the bluff necessitated pushing the

entire structure into the ground, resulting in a substantial portion of the substructure being below lake level and subject to upward hydrostatic pressure. A further restriction placed upon the plant was that no filter washwater, no drainings from the sedimentation basin and no miscellaneous drainage should enter the lake. All sewage and sink wastes will, of course, be delivered into city sewers.

Most of the unusual features of design have resulted from the restrictions above enumerated. To permit the utilization of the roof deck as an ornamental plaza required unusual strength in the roof, and this strength had to be obtained with a minimum of headroom. Where spans were short, a satisfactory result could be obtained with reinforced-concrete construction. Where the spans were long, heavy I-beams were used.

Were it not for the restriction of keeping below the bluff, it would have been more economical to place the bottom of the clear-water reservoir at or but slightly below lake level, at an elevation at which the handling of groundwater would not constitute a problem. The sedimentation basins could then have been built into the bluff. As actually planned, it was necessary to carry the bottom of the filtered-water reservoir down to an elevation of 10 ft. below lake level. This necessitated surrounding the excavation with steel sheetpiling and continuous dewatering of the excavation until the clear-water reservoir was completed and sufficiently loaded on top to resist flotation. Careful consideration was given to the relative economy and safety of weighting the clear-water reservoir with concrete and earth cover and providing means for reducing the upward water pressure. A compromise was adopted. The weight on the roof was substantially increased so that there would be no tendency to float with the lake at ordinary low-water level. In addition, an arrangement of perforated copper pipes imbedded in gravel was provided beneath the reservoir to discharge water into the pipe gallery drains as soon as the lake rises above low-water level.

Storage of washwater

Inasmuch as the washwater from the filters and the water and mud drained out of the sedimentation basins and mixing chambers could not be permitted to enter the lake, it became necessary to construct a revervoir at an elevation sufficiently low to receive the drainage from these elements of the plant. This reservoir is provided with an automatically operated pump discharging into a sewer. Due precaution is taken to prevent sewage backing up into the discharge pipe. It was also deemed advisable to provide facilities for slowly draining the contents of the washwater reservoir into the intake pipe, thus mixing it with the raw water. Whether it will be feasible to return the spent washwater into the raw water as a normal operating practice remains to be seen, but it is thought that it may be beneficial when coagulation is difficult.

The supernatant water from the sedimentation basins may also be diverted back into the intake whenever a reservoir is being drawn down for cleaning. The mud from the bottom of the basins may be discharged into the sewers or, if it proves practicable, may be pumped out of the receiving reservoir through a temporary pipe line into the lake, timed for periods when the bathing beach is not in use. Thus with proper foresight it may be possible to operate the plant without discharging anything other than sewage into the sewers.

Steel intake drum

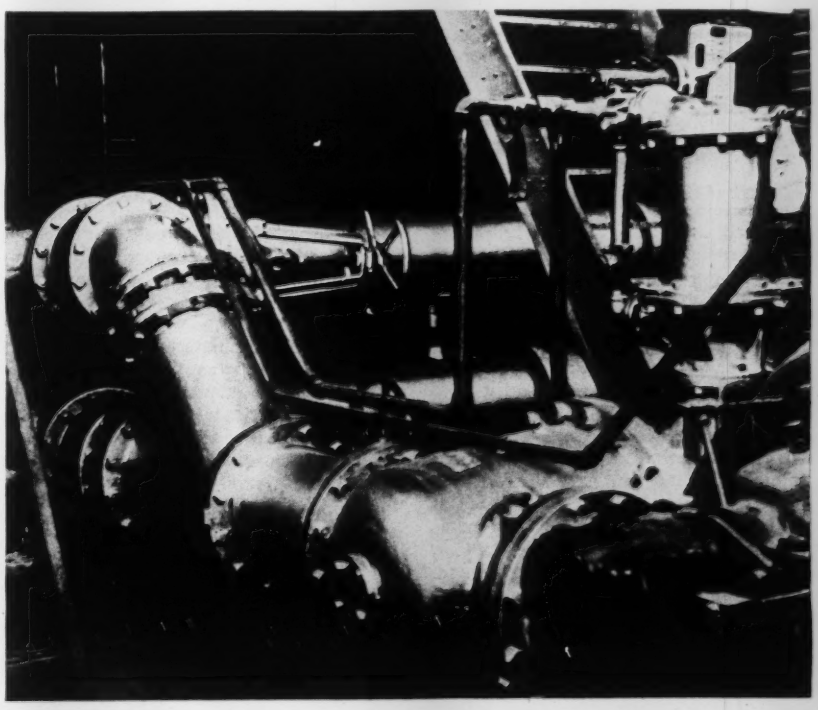
Experience with lake intakes indicates that a depth of 30 ft. or more is desirable to prevent trouble from frazil or slush ice in times of severely cold weather. The best protection to intakes involves creating conditions that will avoid vortices, and this in turn means a relatively dispersed flow and low velocity toward the intake ports. To attain a depth of 30 ft. offshore from the waterworks meant an intake length of about 5,000 ft. and a diameter of not less than 33 in. This would involve considerable expense, and accordingly it was decided to extend the intake out into the lake a distance of 3,000 ft., at which point the water depth is about 23 ft. Although for this length of pipe a 30-in. diameter would be sufficient, it was believed advisable to make the pipe 33 in. in diameter so that it could be extended to a greater depth at some future time should serious ice trouble be encountered.

To minimize the accumulation of ice on the intake, intake drums are used. These drums consist of a steel vessel or pot, circular in plan, resting a few feet below lake bottom. Between the upper edge of this pot and a flat steel roof or cover are the inlet ports. The vertical height of the ports is 3½ ft. The cover disk is substantially larger in diameter than the pot to assist in discouraging the formation of vortices. To prevent the entrance of large clogging particles, the ports are protected by wooden racks. Wood is used because there is less tendency for frazil ice to adhere to wood than to steel or cast iron. The port openings are designed on the basis of a maximum velocity through them of 0.10 ft. per sec., which will occur only when the filters are enlarged to twice their present capacity and are being operated to their maximum capacity of 18 m.g.d.

Plant arrangements

Nothing about the general arrangement of the filter plant proper or its design is especially unique or unusual. In devising the layout, however, an effort was made to produce as compact and convenient a grouping as possible. All the operating elements of the filters, the mixing chambers and the sedimentation basins are readily accessible both

FIG. 5—DISCHARGE MAINS in duplicate from the low-lift pumps.



for observation and operation within the filter-operating room. The chemical preparation and feed devices are on the same level as the filter-operating floor and readily accessible. The filter room can be viewed through a window from the chemical laboratory, and both the laboratory and office are but a few steps from the filter room. A balcony at the level of the offices and laboratory permits general observation of both the low-lift and the high-lift pump rooms.

Preliminary treatment

The mixing or reaction chambers, of which there are four, are provided with variable-speed, electrically operated stirring arms, adjustable as to height and angle of inclination. The angle of inclination in turn affects the degree of vertical mixing. The chambers have a retention period of 35 min. at nominal plant capacity.

The sedimentation basins have a nominal retention period of four hours, a rather longer time than has been provided in most plants dealing with Lake Michigan water. It has been found in practice, notwithstanding the fact that Lake Michigan is of practically constant chemical content and rarely subject to high turbidities, that long sedimentation periods are necessary effectively to combat organisms that are numerous in the summer when the water is clearest.

There are four filters, each of 1.5-m.g.d. nominal capacity. Filter material consists of 30 in. of sand, with an effective size of 0.55 m.m.. A 20-m.g.d. pump supplies washwater sufficient to give a vertical rise of 42 in. per minute.

The filtered-water reservoir has a capacity of 1.28 m.g.

There are five high-lift pumps having a combined capacity of 18 m.g.d. The sizes are as follows: one, 1.5 m.g.d.; one, 2.8 m.g.d.; two, 4.4 m.g.d.; one, 5.75 m.g.d.

Duplications and flexibility

Special effort has been made to avoid the possibility of shut-down. Practically any piece of pipe, any valve or any operating element in the entire system may be thrown out of service without preventing water from reaching the distribution system. This is accomplished by loop systems of piping in the pump rooms, duplicate mains leading to the distribution system and duplicate raw-water discharge pipes to the filters.

The effluent pipes from the filters enter a common collecting pipe from which water can be pumped directly by the high-lift pumps. This permits emptying the clear-water reservoir for cleaning or repair without shutting down the plant. This collector piping is so arranged and valved that any portion of it may be broken or thrown out of service without preventing water from reaching either the clear-water reservoir or the pumps directly.

The header pipe carrying settled water from the sedimentation basin is so valved that at least half of it together with half of the filters can remain in service in case of damage to a valve or piece of pipe.

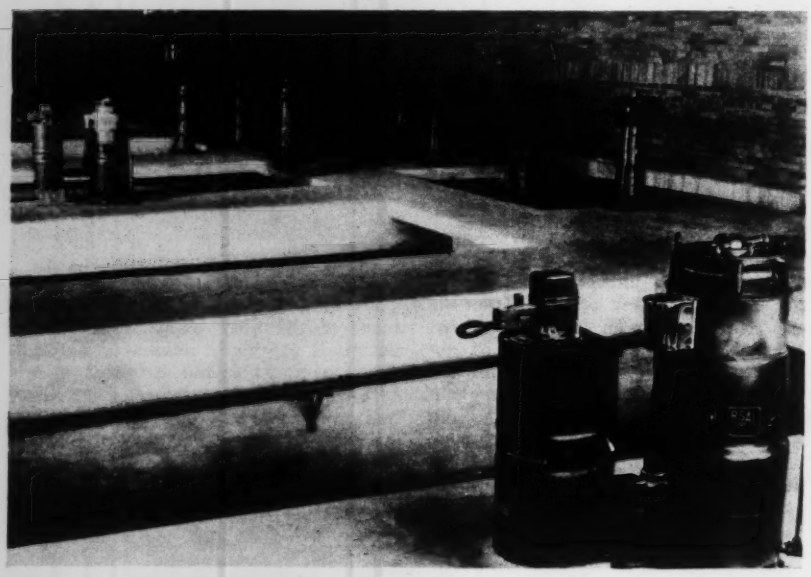


FIG. 6—REDUCTION GEAR and control box for mechanical mixer. Four mixing chambers are provided, each equipped for mechanical agitation. At the opening near the wall is the weir inlet to the sedimentation basin.

Construction handicapped by limited space

Progress of construction was handicapped by a limitation of space. To avoid controversy with the park board, which was not entirely friendly to the chosen location of the waterworks, it was deemed politic to require the contractor to confine his operations to the rather narrow strip of city property extending from the street to the lake. The situation in this respect was further complicated by the requirement in the contract that the contractor maintain a separation between beach sand and clay excavation so that the sand beach might be restored unmixed with clay. To accomplish this, the sand excavation was piled on the beach in an outer circle and the clay was piled mostly in an inner circle. The limited space available made it necessary to place some of the clay spoil close to the steel sheeting that supported the relatively deep excavation for the filtered-water reservoir. The superincumbent weight caused the sheeting to give way, and it became necessary to resort to quick rehandling of the clay and the rectification of the sheeting. The space available for the clay spoil was so limited that a substantial mixture of clay with the sand resulted. The contractor was then required to carry this mixed material away from the work at considerable expense.

Concrete batching at railroad siding

Again because of limitation of space it was not practicable to store materials for concrete on the job. Accordingly, the concrete was batched near the railroad siding where the materials were delivered a mile from the work. The batched materials were delivered to the work in trucks and there mixed with an appropriate amount of water. To supervise the batching of the concrete required an additional engineer inspector, whose duty it was to determine the moisture content of the sand and gravel and to check the accurate proportioning of material.

All the moisture determinations were made by the Dunnigan method and served as a basis to fix the amount of water to be added in the mixer on the job. (See *Bulletin 113*, Iowa Engineering Experiment Station, Ames, Ia.)

The first unusual construction problem ecountered was in connection with the excavation for the clear-water reservoir. While this excavation was made in normally stiff clay, the weather at the time was rainy so that it became saturated with water. A layer of soft semi-liquid mud covered the entire bottom of the excavation. This was deemed unsuitable as a foundation for the floor, and accordingly the contractor was required to level off the excavation to hard undisturbed clay and refill to grade with lean concrete. The wisdom of this procedure is more or less evidenced by the fact that, notwithstanding the large area of this 95x135-ft. reservoir, only three cracks developed in the entire structure. These were hair cracks, no doubt due to temperature changes, and they resulted in no appreciable leakage. They were chipped out and calked with lead wool. The slow tempering of the concrete due to low

temperatures may also be responsible for the relative freedom from cracks in the structure.

Laying the intake pipe

The construction of the intake involved a few interesting details. The intake is made of steel pipe, 33 in. in diameter, and has a plate thickness of $\frac{5}{8}$ in. The contractor was required to exercise great care in lowering the pipe to avoid injuring a heavy bituminous coating that was applied as a hot dip at the factory. The pipe was laid in 120-ft. lengths with Victualic joints, bolted under water. At the shore end and for a distance of 300 ft. into the water the pipe was laid from a pile platform, all operations being carried on from the land end. This method was necessitated by the shallowness of the lake near shore, which prevented the use of floating equipment. A derrick, mounted on the platform, was used for excavation and also for handling the pipe.

Where floating equipment could be used, the lengths of pipe were capped at the end, floated into position, and lowered into a dredged trench. The position of each pipe was marked by pile bents, one bent for each end of each pipe. The cross-timber on top of the pile bents was 7 to 9 ft. above water level. Attached to the cross-timber were cable lines operated by a hand winch, with which the pipe was lowered accurately and steadily into position after water had been admitted. The joints were bolted by a diver, after which each joint was inspected by the resident engineer in a diving suit before the trench was backfilled.

The work of laying the intake pipe moved rapidly when weather conditions were favorable, but unfortunately it is rarely practicable to lay pipe in Lake Michigan for more than about 90 days out of the year. Work on such a contract is therefore hazardous. With good luck a contractor may complete the work within a few summer months. With poor luck he may find it necessary to keep his equipment on the job for another season. This is what actually occurred in this instance. During the summer of 1933 the intake was completed with the exception of about one length of pipe and the intake drums with their connections. Nothing further could be done until the spring of 1934. For the first few months of operation water was drawn through a temporary upturned tee with bars across the end to exclude large drift.

Loop piping saves shutdown

When the plant was placed in operation, an accident occurred to illustrate the value of a design that seeks to prevent shutdown regardless of any emergency. In fastening tierods on the 20-in. high-lift discharge piping a nut too large for the threads was used on one of the tierods. The nut was small enough just barely to take hold of the threads. The workmen evidently did not trouble to tighten the nut with a wrench.

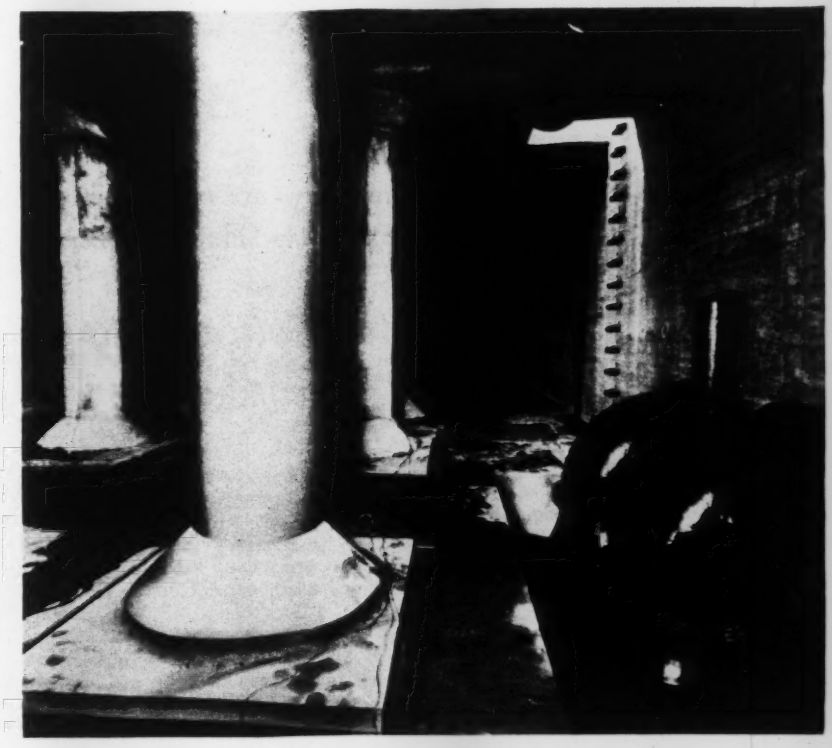


FIG. 7—CLEAR-WELL INTERIOR. Suction bells for high-lift pumps are in the right foreground. Just beyond them can be seen a dark cross set in the floor against a white-tile background. The clarity of the water can be judged by viewing the cross from the engine room through the sighting tube, which can be seen just beyond the ladder. The roof of the clear well forms the floor of the filters.

Shortly after the full pumping pressure was put on the pipe, a leaded joint pulled out, stripped the nut off the rod and caused two flanges to break. Within a few minutes the valves on either side of the break were closed and, because the discharge piping was looped, operation was not interrupted. The pump-room floor was flooded to a depth of 3 in., but this rapidly drained away into the station sumps and was automatically pumped into the sewer. The accident left one of the five high-lift pumps out of service for about a week.

To provide against material damage from a similar future accident, it is proposed to provide electric control equipment that will automatically close a valve on the main discharge from the pumping station and also shut down all high-lift pumps when the discharge pressure falls to such a level as would result from a serious break.

Late grinding of concrete costly

An incident occurred during the period of construction which may constitute a timely warning to contractors. The specifications required that certain concrete surfaces were to be ground with carborundum wheels to produce a smooth surface, and it was further stated that this grinding should be done as soon as the forms could be removed. The contractor, however, delayed the grinding and, in fact, sought to avoid grinding by painting the surface with neat cement. After a lengthy controversy the contractor was forced to grind the surfaces to a smooth finish, but by this time the concrete had become so hard that the grinding was extremely slow and laborious, so that it cost him at least three times what it would have cost had he ground the surfaces as required by the specifications.

Principal contractors on the work were as follows: waterworks structures, Owen Engineering Co., Chicago; pipe and filter equipment, E. W. Bacharach Co., Kansas City, Mo.; pump equipment, Allis-Chalmers Manufacturing Co., Milwaukee; electrical equipment, Wadeford Electric Co., Chicago; intake into Lake Michigan, Merritt Chapman & Scott Co., Chicago.

The work was designed and the construction supervised by Greeley & Hansen, consulting engineers, Chicago. Paul Langdon of this firm was in charge of designs. J. M. Nemoyer represented the consulting engineers as resident engineer throughout the construction period.

C. M. Osborn was village manager (resigned in May) and B. H. Platt is city engineer.

MORE WATER URGENTLY NEEDED BY NEW YORK CITY

ALTHOUGH conservation measures are helpful, under best conditions the city will be at the limit of its water supply by 1940 unless Delaware River water is then available

By Walter E. Spear
Acting Chief Engineer, Board of Water Supply, New York City

AS A RESULT of the delay in new waterworks construction, largely due to legal and financial difficulties, the city of New York now has hardly more than sufficient water to meet its present needs. Reasonably adequate rainfall has kept the reservoirs full since the drought of 1930-1931 and concealed the impending shortage in supply; misleading publicity has confused the issue. But in reality the situation is grave.

Delaware River supply proposed

The city anticipated the present water supply situation in 1922 and, through the agency of the board of water supply, began looking around for new sources of supply. The Delaware River in New York was found to offer the best and cheapest supply, and, after fruitless efforts to negotiate a division of the waters of this interstate stream between the states of New York, Pennsylvania and New Jersey, New York was advised by eminent counsel that it could take the Delaware River water in New York without the consent of the other states.

The Board of Estimate and Apportionment approved the Delaware project on Jan. 12, 1928, the State Water Power and Control Commission on May 25, 1929. Further progress was stayed by New Jersey, which brought an action before the Supreme Court of the United States on May 22, 1929, to prevent the proposed diversion. The case was conducted before a special master, and it was not until May 4, 1931, that the Supreme Court confirmed the report of the special master giving to New York the right to develop a portion of the upper waters of the Delaware River within the state of New York.

Delaware construction delayed

Before the construction of the Delaware aqueduct could be started, the city's credit became impaired and no funds have since been available for this project. In the meantime, various emergency measures, comprising small additions to the present waterworks and projects for reducing the water consumption that have been advanced by other agencies, appeared to offer, in a period of financial stress, the possibility of postponing the heavy cost of the Delaware project. The results to be obtained from these emergency measures have been optimistically estimated by their proponents; the predicted results cannot be realized, and at best these measures are wholly inadequate to warrant any postponement of the Delaware project. Construction of the Delaware works, on the other hand, has been so long delayed that most of these emergency measures have indeed become necessary to prevent a shortage of water before the first stage of the Delaware project can be finished.

Except during periods of depression or on occasions of actual shortage in supply the use of water in New York City has been constantly increasing during the past half century, as shown in Fig. 3. In 1930, at the beginning of the present industrial depression, the total use of water by New York City, including that supplied within the city by the private water companies and that delivered from the city's waterworks to other communities, mainly in Westchester County, amounted to 1,017 m.g.d. This is only 22 m.g.d., or about 2 per cent, less than the safe yield of all existing sources of supply, 1,039 m.g.d.

Evidently, the additional draft available, but not used, from the Croton and Long Island watersheds in 1930 was nearly offset by the overdrafts on the Catskill watersheds and on the works of the private water companies. Had the normal annual increase in consumption, averaging 28.2 m.g.d. in the previous ten years, continued after 1930, the existing supply would before now have been exhausted.

Low consumption only temporary

From 1930 to 1932 the average consumption fell off, however, to 957.6 m.g.d., or nearly 6 per cent, which was a result of the decline in business, manufacturing and commerce, the abandonment of houses and apartments, and the consolidation of many families in fewer apartments. It is already evident, however, that such reduced rates of consumption may not be considered permanent. The average daily consumption in 1933, even with a sharp drop in use outside the city, was 958.2

FIG. 1—VALLEY OF RONDOUT CREEK, in the vicinity of the proposed Lackawack Reservoir.

TABLE I—RELATION OF CONSUMPTION TO SUPPLY IN 1930

Source of Supply	Average Daily Consumption of New York City from Municipal Sources and Private Water Companies, and Amounts Delivered to Other Communities from Works of New York City, M.G.D.	Estimated Safe Yield of All Existing Municipal Sources of Supply and of Private Water Companies in the City, M.G.D.
Municipal		
Croton	261	320
Catskill, Bronx and Byram system	607	510
Long Island	79	139
Staten Island	6	10
Total municipal	953	979
Private water companies	64	60
Total	1,017	1,039

m.g.d., slightly greater than that in 1932; and the average daily consumption during the first three months of the current year averaged about 1,014 m.g.d., about 85 m.g.d. greater than that during the corresponding months of the previous year, and about 34 m.g.d. greater than the previous maximum during the same months of 1930.

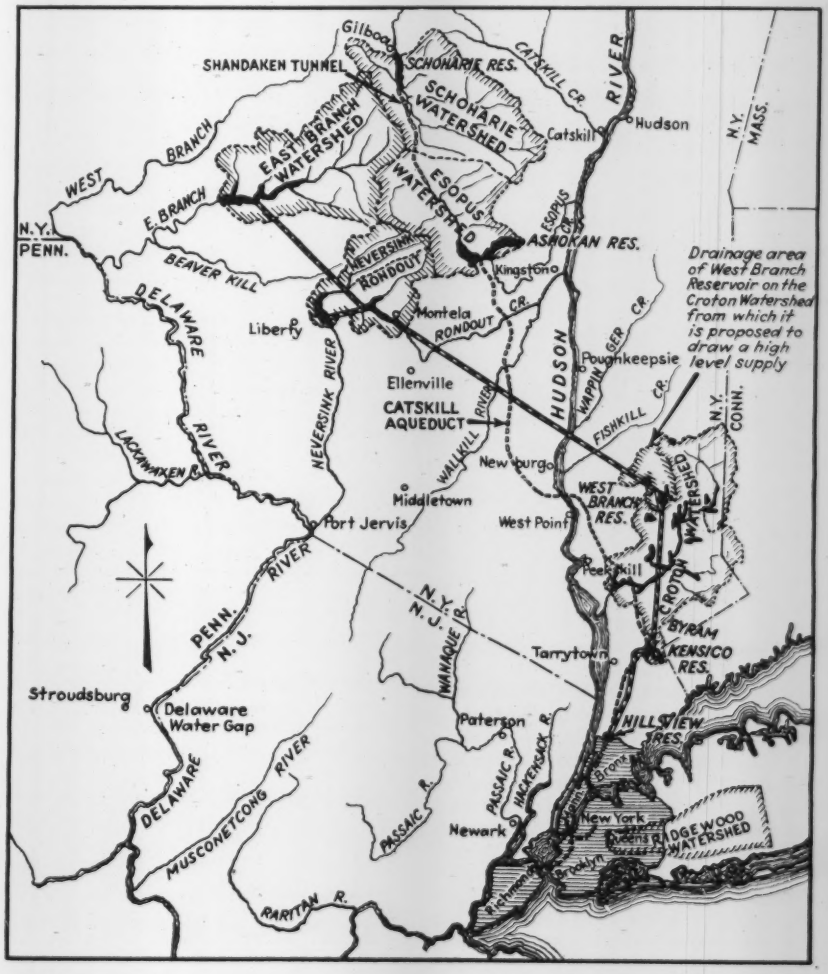
No doubt much of the increase this year was caused by the abnormally low temperatures of the first three months, but waterworks facilities must be built to meet just such conditions. All available evidence points to a continued growth in population and an early recovery in the business of the city. There have doubtless been some shifts in population but probably as many people have come to the city as have departed. When normal business returns we may reasonably expect, as after previous depressions, a normal use of water corresponding to the upper line in Fig. 4, providing no effective measures are taken to reduce the consumption. Even if the increase in demand is not quite so great as this prediction during the next few years, it is evident that the consumption of water in the city is now so near the available supply that not only may no time be lost in starting the Delaware project, but every effort must be made to supplement the existing sources by such emergency supplies as can be quickly developed, at the same time keeping down the consumption and stopping all preventable waste.

The Delaware project

The Delaware project, as modified by the decision of the Supreme Court on May 4, 1931, contemplates the development of two tributaries of the Delaware River, the East Branch and the Neversink River, and of the upper Rondout Creek, a tributary of the Hudson River, by the construction of reservoirs on those streams and the delivery of an estimated supply of 540 m.g.d. through a pressure-tunnel aqueduct across the Hudson River Valley to the West Branch Reservoir of the Croton system, and thence southerly through the Kensico Reservoir to the Hill View Reservoir in the city of Yonkers, just north of the New York City line. As a part of the project, it is also planned to pick up about 100 m.g.d. high-level water in the Croton watershed and deliver that water in the city about 160 ft. above the level of the Croton supply, thus reducing the cost of pumping. The total cost of this project was estimated at $272,587,000.

The Board of Estimate and Apportionment, on April 17, 1931, authorized $50,000,000 for the construction of the southerly portion of the Delaware Aqueduct, in Westchester County from Kensico Reservoir to Hill View Reservoir, which will feed the new city delivery tunnel now approaching completion, the Kensico-Hill View tunnel being necessary whether the new water supply was to come from the Delaware watershed or elsewhere. Immediately after the favorable conclusion of the litigation before the Supreme Court, the Board of Water Supply, on May 20, 1931, filed the real estate maps for the northerly portion of the Delaware Aqueduct in Ulster, Orange and Dutchess counties, from the proposed Rondout Reservoir to West Branch Reservoir, and requested an authorization of $78,859,000 for its construction. No action on this request was taken by the Board of Estimate and Apportionment; on the contrary, with the city finding itself in financial difficulties, that body on April 1, 1932, withdrew the authorization previously made for the southerly section of the Delaware Aqueduct. Surveys and office studies have since been continued with a small force by the board of water supply, but the Dela-

FIG. 2—PROPOSED NEW SOURCES OF SUPPLY for New York. New impounding reservoirs are proposed on the East Branch of the Delaware River and on Neversink Creek streams, which flow into the Delaware, and one reservoir on Rondout Creek, which is a tributary of the Hudson River. An additional area on the Croton watershed will also be developed.



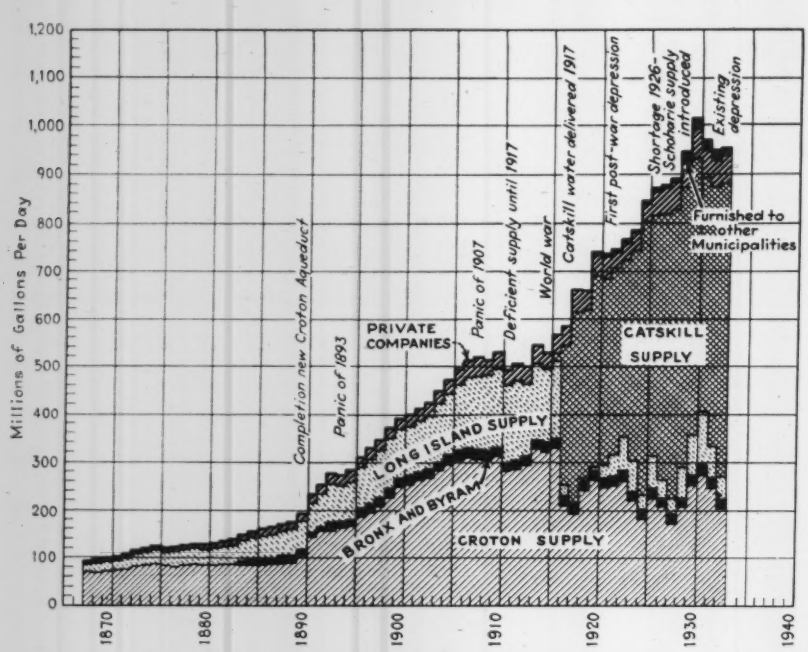


FIG. 3—WATER CONSUMPTION in New York City since 1868, subdivided as to source of supply.

ware project has otherwise been at a standstill for two years.

Emergency supplies for the city

In the meantime several proposals to provide additional emergency supplies have been advanced by the department of water supply, gas and electricity, which maintains and operates the existing waterworks. These plans have unfortunately been looked upon in some quarters as one of several measures that will permit of postponing at a time of financial stress the large expense of the Delaware project. This represents a very short-sighted view of New York's water-supply situation. Supplemental emergency supplies are indeed necessary in order to minimize a water shortage until the first stage of the Delaware project can be finished, but such supplies cannot be considered as a substitute for the Delaware project. They do not provide sufficient water even on the basis of the capacity that has been estimated by their proponents, and it would be prudent to consider their yield as considerably short of the published estimates.

Several sources that may be quickly developed as emergency supplies were proposed from time to time by the department of water supply, gas and electricity. According to the estimates of that department, these sources would supply 146 m.g.d., as shown in Table II.

The first project listed involves pumping from the unregulated flow of Rondout Creek directly into the Catskill Aqueduct. It has been approved by the State Water Power and Control Commission, subject, however, to many limitations. For example, only the excess flow over 60 m.g.d. (100 m.g.d. at certain times) may be pumped, and no pumping whatever may be done during July, August and September. The plan provides no storage, and no opportunity for sedimentation of turbid flood waters before their delivery into the aqueduct. The commission further requires, among other things, that the city clean up the watershed, build some sewage collection and treatment works for the larger towns, chlorinate the water at the pumping station, chlorinate the entire flow of the Catskill Aqueduct twice below the connection from the pumping station, separately chlorinate the supply to each of the dozen or so communities or institutions, taking water from the Catskill Aqueduct north of the Kensico chlorinator, and, if the commission should so determine, filter the entire pumped supply at High Falls. During the dry period of 1930-1931 it would have been impossible, under these conditions, to pump an annual average of more than 50 m.g.d., nor could the annual yield have been increased in this instance by more than this amount by pumping before the drought. When the proposed Lackawack Reservoir of the Delaware project on the upper Rondout Creek is built and the waters of 94 sq.mi. of the Rondout Creek watershed are diverted into the Delaware Aqueduct, the yield of the High Falls pumping plant will be materially reduced. It is, therefore, purely an emergency project, of little value after the completion of the first stage of the Delaware project, an emergency project, moreover, whose dependable yield will be reduced when most needed, during the years immediately preceding the completion of the Delaware project while the Lackawack Reservoir is being filled. Nevertheless, the Delaware project has been so long delayed that even this unsatisfactory source will probably have to be developed to tide over the emergency.

Plans have been considered for some years by the department of water supply, gas and electricity for further development of the deep groundwaters of western Long Island within the watersheds of the Ridgewood system and the borough supplies. The State Water Power and Control Commission last year denied the city's application to sink deep wells in Nassau County on the ground that further diversion of the waters of that county would be prejudicial to the rights of the local communities. No decision has yet been made by the commission on the city's application for permission to sink additional wells in Kings, Queens and Richmond Counties within the limits of New York City. In the hearings it was brought out that the groundwaters of Kings County and a portion of southern Queens County have been seriously overdrawn, as evidenced by the lowering of the water table in some localities below sea level. Even in northern Queens County the groundwater map, agreed upon by the engineers of the city and the private water companies opposing the city's plans, show that the water table has been drawn considerably below the normal levels of 1903.

The Richmond County water horizons in Staten Island have never been considered as favorable as those of Long Island, and the limit of their yield of potable water under the methods of development hitherto employed has seldom been estimated to be much greater than that of the present works.

With an estimated yield of 50 m.g.d. from the High Falls project on the lower Rondout and 46 m.g.d. from western Long Island and from Staten Island the maximum possible emergency supply from the sources proposed by the department of water supply, gas and electricity would amount to 96 m.g.d. If the State Water Power and Control Commission denies any portion

TABLE II—YIELD OF PROPOSED EMERGENCY SUPPLIES AS ESTIMATED BY THE DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY

	Estimated Yield, M.G.D.
Pumping from Rondout Creek into the Catskill Aqueduct at High Falls, N. Y.	100
Additional wells in Kings and Queens Counties	31
Additional wells in Richmond County	15
Total	146

TABLE III—POPULATION AND CONSUMPTION OF NEW YORK CITY AND OTHER COMMUNITIES SERVED FROM 1917 TO 1933 INCLUSIVE

Year	Population of New York City as Estimated by the Department of Health July 1	Average Daily Consumption of New York City from Municipal Works and Private Water Companies, M.G.D.	Corresponding Average Per-Capita Consumption in New York City Gal. Per Day	Average Daily Supply Furnished Other Municipalities, M.G.D.	Total Average Daily Consumption of New York City and Other Municipalities Supplied, M.G.D.
1917	5,400,000	584.6	108	0	584.6
1918	5,488,000	659.2	120	0	659.2
1919	5,576,000	660.2	118	0	660.2
1920	5,684,000*	734.9	129	0.4	735.3
1921	5,812,000	731.3	126	0.7	732.0
1922	5,939,000	742.5	125	0.6	743.1
1923	6,067,000	761.6	126	4.1	765.7
1924	6,195,000	780.2	126	4.0	784.2
1925	6,323,000	839.6	133	6.7	846.3
1926	6,451,000	863.3	134	9.0	872.3
1927	6,579,000	868.1	132	7.9	876.1
1928	6,707,000	877.8	131	10.7	888.5
1929	6,835,000	940.4	138	19.0	959.4
1930	6,962,000†	995.9	143	21.5	1,017.4
1931	7,090,000	938.9	132	20.6	959.5
1932	7,218,000	935.7	130	22.0	957.7
1933	7,346,000	941.4	128	16.8	958.2

*U. S. Census 5,620,000. †U. S. Census 6,930,000.

of the city's program for additional wells in the city, this total will be correspondingly reduced. Adding this possible increment of 96 m.g.d. to the estimated yield of existing sources gives a total yield of not more than 1,135 m.g.d., which must suffice for the city until the first stage of the Delaware project is completed.

Elimination of waste and leakage

The population of New York City, the total average daily consumption of water in the city and in other communities supplied by the municipal works, and the per-capita consumption of the city during the past seventeen years since the introduction of the Catskill supply are shown in Table III above.

The policy of universal metering was urged upon the previous city administration last year by the Mayor's committee on additional water supply, the so-called "Grimm Committee," as a means of postponing the large expense of making a major addition to the city's water supply. No competent engineer will question the wisdom of metering, cost permitting, as a measure of good administration any more than we would now question the metering of gas and electric current, but metering should not be considered in a growing city as a substitute for new sources of supply. The extravagant claims put before the above committee as to the amount of waste to be saved by universal metering are not substantiated by an analysis of the results obtained in other large American cities, when the conditions existing in New York are properly considered.

There are many reasons why a smaller reduction in consumption is to be expected from universal metering in New York than in many other cities. A few of these reasons can be listed as follows:

1. The large reduction that usually follows the metering of the large industrial consumers has already been made. Substantially, all industrial consumers and some 28,000 domestic consumers are already metered.

2. Per-capita consumption in New York is low compared with the other American cities most nearly like it in size and percentage of service metered, as shown by Table IV.

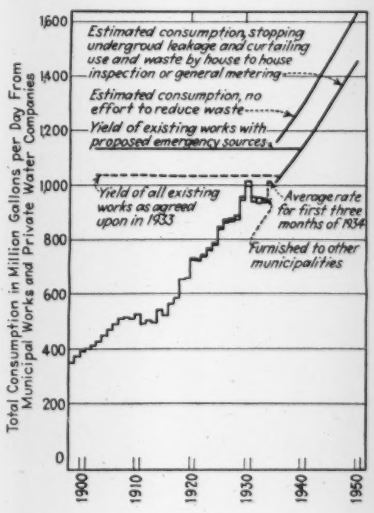
3. It is true in a general way that the larger the city the greater is the normal per-capita water consumption. New York, in spite of its size, not only has a smaller per-capita consumption than the cities listed in Table IV, but its per-capita consumption is but little more than that of comparable fully metered cities, notwithstanding the fact that these other cities are much smaller (see Table V). This indicates that there cannot be any large amount of waste that could be cured by meters.

TABLE IV—1930 PER-CAPITA CONSUMPTION OF THE LARGER PARTLY METERED CITIES

City	Population Served	Per-Capita Consumption, Gal. Per Day	Per Cent of Services Metered
New York	6,962,000	143	23.6
Chicago	3,439,500	296	20.8
Philadelphia	2,000,000	170	42.0
St. Louis	890,000	138	8.6
Buffalo	595,000	199	14.1
Pittsburg	579,000	184*	43.6
Washington	486,900	167	85.1

*It was recently stated, in support of universal metering for New York, that Pittsburg was 100 per cent metered and had a per-capita consumption of but 77 gal. per day. These figures were those of one of the private water companies supplying certain outlying wards and adjacent suburban territory.

FIG. 4—RELATION between growth of water consumption and safe yield of existing supplies. If proposed emergency supplies are put into service and conservation measures are highly successful, water from the Delaware will be essential in 1940 if a shortage is to be averted.



4. The rate of annual increase in daily consumption in New York (0.9 gal. per capita from 1900 to 1930) is no greater than the average of the fully metered cities (Table V); it probably reflects only the normal increase incident to the great business and industrial expansion and the rising standard of living during that period. It certainly does not indicate that such waste as existed is increasing, and it gives little promise of a large reduction by universal metering.

5. The cost of plumbing repairs in New York is high, and the meter rate, even with the recent increase, is not high, so that it will frequently be cheaper to let a fixture leak than to call a plumber.

6. The last and perhaps the most important reason for concluding that general metering will effect comparatively little saving in New York is the fact that two-thirds of the families live in apartment and tenement houses and are wholly indifferent to the amount of the landlord's water bills, and only one-sixth of them live in one-family houses and would pay their own meter bills. Considering all these factors, it is esti-

TABLE V—CONDITIONS AFFECTING SUCCESS OF METERS IN REDUCING WASTE OF WATER
(All Data for 1930 Except as Noted)

City	Population Served	Per-Capita Consumption	Per Cent of Services Metered	Per Cent of Total Families in One- and Two-Family Houses	Maximum Domestic Meter Rate, Cents per 1,000 Gal. 13 in 1930 20 in 1934	Mean Annual Rate of Increase in Consumption Before the Current Depression, Gal. Per Capita
New York	6,962,000	143[1]	23.6	33	20	0.9
Detroit	1,822,159	138	99.0	79	9	—0.3[4]
Cleveland	1,185,000	150	99.0	76	8	2.4[4,5]
Boston	781,270	118[2]	100.0	50	25	0.4[6]
Milwaukee	578,249	132	98.9	80	8	1.3
Cincinnati	502,895[3]	126[3]	98.0	68	16	0.6[4,6]

[1]This is the highest average annual rate ever observed; the per-capita consumption in 1933 was 128 gal. per day.
[2]Note that Boston has unusually high meter rate.
[3]Estimate of 1929.
[4]These rates of increase are undoubtedly abnormally low due to active work in stopping underground leaks, particularly in Detroit, where this work was carried on aggressively throughout the ten-year comparison period.
[5]Fifty per cent increase in meter rates in the middle of the comparison period reduced the increase in consumption.
[6]Period of complete metering too short before the depression to give a reliable trend; Boston did not become 99 per cent metered until 1928, Cincinnati not until 1926, with a slight decline since.

mated that it would be impossible, under New York conditions, to reduce the average per-capita daily consumption by more than 10 gal. and the average daily consumption by more than about 80 m.g.d. by universal metering; and that this could not be accomplished in less than five years, or before 1939. The capital cost of general metering may be conservatively placed at about $30,000,000.

The department of water supply, gas and electricity has carried out effective campaigns of house-to-house inspection for short periods in the past and estimated, as of 1932, that 75 m.g.d. could be saved at an annual cost of about $200,000. This would be equivalent to more than 80 m.g.d. in 1939, as much as can be saved by general metering, with no capital outlay, and at a fraction of the annual cost. If underground leakage can in fact be reduced, as has been stated, to 3.4 per cent of the consumption, an achievement believed to be without precedent in any large American city, a further saving of about 70 m.g.d. as of 1939 can be made. The total possible reduction by both the stopping of underground leaks and either universal metering or house-to-house inspection does not exceed about 150 m.g.d. as of 1939. Deducting these savings from the probable total consumption based on present methods of control and the assumption of a return to normal business conditions, the minimum consumption of water to be expected during the next fifteen years is as shown in Fig. 4.

KENSICO DAM, one of the structures on the Catskill system. The reservoir behind it is utilized for storage and sedimentation.

Exhaustion of all supplies

With the increment of 96 m.g.d. that can possibly be added to the city's water supply from emergency sources, it may be seen from Fig. 4 that the city will have exhausted its water supply in 1940. If the Delaware project could be started at once, it would hardly be possible with the best of good fortune to obtain any water from that project by 1940; and the delivery of the first supply might be delayed a year or more by financial, legal or construction difficulties. Anything short of the highest efficiency on the part of any one of the contractors building one of the controlling sections of this 90-mile tunnel project, with shafts up to 1,000 ft. in depth, would be fatal.

When, at the suggestion of the department of water supply, gas and electricity, the Board of Estimate and Apportionment requested the board of water supply to seek new sources of water supply in 1921, it was considered that the present sources would be exhausted in 1935 and that there was not then too much time in which to make the necessary plans and complete a large addition to the city's water works before additional water would be needed. We are now considerably farther ahead on the Delaware project than was the board of water supply on the Catskill project when the board was organized in 1905. The first contract on the Catskill system was let two years later in 1907, and it was nearly ten years more before the Catskill supply was delivered to the entire city in January, 1917. We can build waterworks more rapidly now than we could twenty years ago when the Catskill works were constructed, but we cannot be sure of being equally fortunate in avoiding serious delays.

Altogether the water-supply situation in New York is now one that should give every citizen the greatest concern.

NEW YORK SUPPLY REQUIRES DIVERSITY OF TREATMENT

WIDE VARIETY of types of water makes it necessary to consider pollution, turbidity, hardness, aggressiveness, tastes and odors and micro-organisms—Sewage plants operated to protect watersheds

By Frank E. Hale

Director of Laboratories, Dept. of Water Supply, Gas and Electricity, New York City

THE VARIOUS SOURCES of water supply for New York City represent practically all the types found in the North Atlantic coastal region. The waters vary in quality from very soft colorless surface water of the Catskill Mountains to hard saline waters taken from certain areas of Long Island and Staten Island. Because of this wide variety, to assure a satisfactory water supply to the city at all times involves nearly every problem in water treatment met with the country over. To a greater or less degree it is necessary to cope with pipe corrosion, chlorides, iron, hardness, bacterial pollution, turbidity, tastes and odors, and micro-organisms.

To begin with, all of these supplies present problems in corrosion. The Catskill water is corrosive because of its great purity. Though averaging only 3 p.p.m. of free carbonic acid, its alkalinity is so low (averaging only 8 p.p.m.) that it is very aggressive of piping containing iron. But it does not attack to any serious extent brass, copper, or lead; on the other hand, most of the well supplies contain large amounts of carbonic acid, to say nothing of nitrates, chlorides and sulphates of calcium and magnesium. These waters in general do not seriously attack iron but do rapidly dezincify ordinary brass pipe. The answer to the problem appears to be to choose the most resistant material for a particular water: cement-lined mains coated with asphalt for Catskill water, with brass, red brass or copper for house installation; and for the well waters cast-iron mains, with red brass, copper or admiralty metal in dwellings and industrial buildings.

Several other problems are connected with the groundwaters. Infiltration of salt water raises the chloride content to large amounts in some instances. Though not harmful to health, a saline taste is developed beyond about 250 p.p.m. Hardness simultaneously increases and adds to the saline taste.

If the sum of the chloride and hardness content amounts to 400 p.p.m., even though chlorides are less than 250 p.p.m., saline tastes begin to be noticed. Hardness, of course, is disagreeable for domestic use, and it interferes with many industrial uses of water. One zeolite softening plant has been installed at one well in the Flatbush territory by the New York Water Service Corp. At this plant permanent hardness is removed, and total hardness in the form of carbonate left at 100 to 130 p.p.m. is practically normal for the well waters of this particular area. Other softening plants would undoubtedly be appreciated by the consumers.

Well waters contain iron

A frequent problem on Long Island is the presence of troublesome amounts of iron. Any amount over 0.5 p.p.m. will cause complaint by rust stains on plumbing fixtures and in the laundry and by rendering tea black and bitter. There now exist in this region eight filter plants for iron removal, and others should be installed. These plants are of several types: one is a slow-sand filter with aeration; the rest are rapid filters, four of the gravity type with aeration and three pressure filters. Only one of the last group employs lime to neutralize the carbonic acid. There is no aeration in one case, air is added under pressure in another, and chlorination is used at the third. The last two pump directly from the wells through the filters to the distribution system.

Considerable trouble has been experienced with growths of Crenothrix, Spirophyllum, Achlya, Penicillium, etc., requiring chlorination for control. Stoppage of screens in filters of gas refrigerators has been one result calling attention to these growths.

As a rule very deep wells are free from nitrates, while shallow wells may contain large amounts—2 to 20 p.p.m. Small amounts of hydrogen sulphide and high free ammonia occasionally occur in deep waters due to reduction of sulphate and nitrate respectively. Chlorination readily destroys the hydrogen sulphide and combines with the ammonia to form chloramine.

From a sanitary standpoint, however, these well waters are all excellent, almost entirely free from bacteria and B-coli.

To the east, away from the settled portions of the city, the groundwaters become exceedingly soft, similar to Catskill water. The greater part of the water from the Long Island watershed pumped to Brooklyn is from ground sources. Even the small ponds are spring-fed. About 30 to 40 m.g.d. is available from two infiltration galleries extending for about 5 miles parallel to

FIG. 1—AERATOR at Ashokan Reservoir. The aerator basin is 250 ft. wide and 500 ft. long, and there are about 1,600 nozzles.

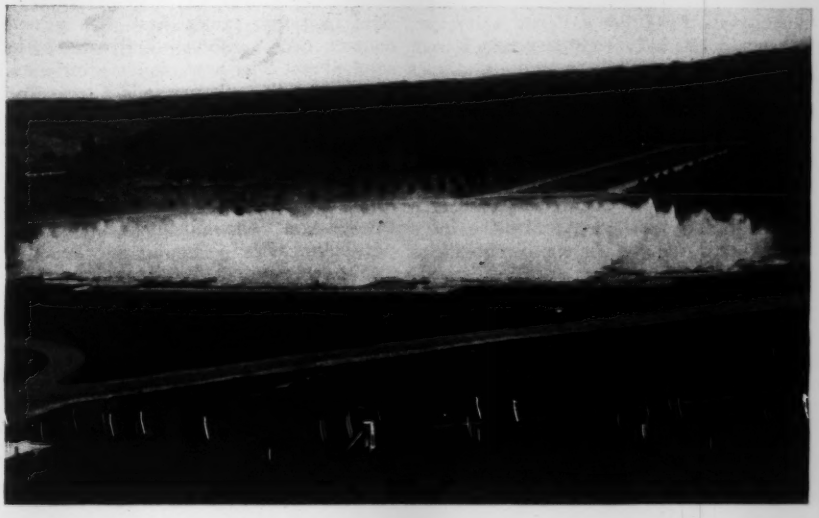


FIG. 2—SEWAGE-DISPOSAL PLANT operated by New York water department at Mt. Kisco on the Croton Watershed. A very high degree of treatment is given.

the south shore and to about 20-feet depth. This water is very soft and of excellent quality. Some wells, however, contain iron, and a few are saline due to infiltration of sea water. Altogether, about 200 m.g.d. is available to the city from Long Island ground sources, including 60 m.g.d. supplied by the private companies.

Protecting mountain supplies

The watershed areas of New York City's water supplies cover over 1,100 square miles. The force protecting the supply from pollution numbers several hundred, counting the engineers, inspection force, laboratory force and laboring gangs. Under the direction of the watershed engineers, inspectors cover regular routes on schedule and include in their duties a search for possible sources of contamination and sickness and sites for new buildings. They also remove animals from streams and warn picnic parties. They report all cases of typhoid, poliomyelitis or other diseases that might affect the water supply, disinfect premises and follow up carriers.

The second protection of the sanitary quality of the mountain water is the tremendous storage. This also has a great equalizing effect. In the Catskill system Schoharie Reservoir has a capacity of 20 billion gallons, Ashokan Reservoir 130 billion gallons, and Kensico Reservoir 30 billion gallons, altogether 180 billion gallons. With a draft of 600 m.g.d., this theoretically would last 300 days. Despite this theoretical safety, storms of such severity have occurred upon the Catskill area that water entering the west basin of Ashokan Reservoir has reached the dam the following morning, as shown by floating debris. However, even such water, if drawn at once, couldn't reach the city for several weeks, as it must first pass through Kensico Reservoir, and by that time 99 per cent of any typhoid bacteria would have perished. Similarly, on the Croton watershed, Croton Lake holds 34 billion gallons, and with the upper dozen and a half large reservoirs and lakes the storage amounts to 104 billion gallons. With draft at safe yield of 300 m.g.d., this storage equals 347 days.

The third protection is sewage disposal. At strategic points on the watershed sewage-disposal plants have been built to care for the sewage of the larger communities. Also, the disposal of private residences is carefully supervised, and advice is given by the engineers as to the method to be used. This also applies to institutions and a few industries such as dairy establishments. To protect streams on Long Island, pan toilets and cesspools are cared for by scavenger wagons at city expense.

On the upper watersheds several plants are owned and operated by the city. These plants produce effluents of the character of ordinary well water, which, except for chlorine taste, are fully acceptable to turn into the water supply. There are six such plants on the Croton watershed, one on the Esopus watershed, two on the Schoharie watershed and one on the Bronx. Complete tests, physical, chemical and bacteriological, are made weekly by the laboratory division.

The Mt. Kisco sewage-disposal plant, built by the city, originally served a population of 3,000. It was enlarged about two years ago, for the population had doubled. The old plant consists of septic tanks, first and second contact beds, sedimentation tanks and sand filters. The new plant comprises a new digestion tank and sand filters. The final effluent from both sets of sand filters is combined for chlorination. Residual chlorine is maintained at over 0.35 p.p.m. The dose of chlorine is kept high to destroy nitrogenous elements of the sewage. The effluent is consistently non-putrescent.

The sewage at Brewster is treated with bleach solution, then passed through a sedimentation chamber, discharged in rotation onto the surface of one of six filter beds, each 100 ft. square and deeply underlaid with tile. The final effluent leaches through soil for a considerable distance into East Branch stream. The high dose of chlorine, about 100 p.p.m., effectively reduces bacteria and destroys B.-coli.

Montefiore Home is a private home for consumptives. The sewage disposal comprises septic tanks, sprinkler beds (the first built in this country), baffled sedimentation tanks and tile drainage field. The final effluent groundwater is directed by an open rock-filled trench and under-tile drains at the bottom and side of the sloping field to a point where chlorine is applied.

At the New York State Reformatory for Women at Bedford, now called Westfield State Farms, the sewage-disposal system consists of three Imhoff tanks, eight sand filters, and chlorination.

All the plants on the Catskill watershed were built and are operated by the city. The Grand Gorge plant has a sludge-collection chamber in which sludge is pumped to separate heated digestion tanks. Sand filters and chlorination complete the process. Results have been uniformly excellent though the sewage is as yet very weak. The Tannersville plant has a covered, baffled sludge-digestion tank in three divisions, followed by sand filters and chlorination. The Phoenicia plant has sludge-digestion tanks followed by sand filters or under-tile field, and chlorination if necessary. Owing to varying population, the filters are used in the summer period, and the tile field in the winter.

The above sewage plants have been mentioned in detail because of the wide variety of methods in use. In addition to sewage plants, toilets of all trains are locked while crossing the Croton watershed.

Chlorination

The fourth protection is chlorination. There are about 110 points equipped for chlorination if required. Counting the city-owned plants, the sewage-disposal systems on the watersheds and the well stations of the private water companies, there were 52 chlorination plants operating in 1933. Of 33 plants owned by the city approximately 29 were operating. The amount of water treated at any one plant varies from a few hundred thousand gallons per day to about 650 m.g.d.

In operation it is aimed to keep residual chlorine at 0.05 to 0.10 p.p.m. at the plant, depending upon its location. If the water goes directly to the distribution system or the B.-coli content is regularly small in amount, the 0.05 p.p.m. residual is maintained. This is true of well stations in the city generally and of certain of the large stations.

Many of the taste complaints are caused by the general practice over the country of carrying needlessly high residual chlorine. It is not necessary for the elimination of B.-coli. We have found that in our Catskill system one-half the absorption value for chlorine will eliminate 90 per cent of the B-coli. For example, if absorption value is

0.10 p.p.m., a dosage of 0.05 p.p.m. will reduce a 10-c.c. positive in the raw water to zero in the treated. Any residual chlorine gives a high factor of safety, and only sufficient is necessary to cover the variation in quality of the raw water, which is usually slow in a stored supply. Increased absorption of chlorine is frequently caused by sudden growths of microscopic organisms such as Synura, Uroglena or Asterionella.

Chlorine dosage is controlled by determination of residual chlorine, by bacterial examination and by determination of increase in fixed chlorine. Both residual and fixed chlorine are determined before and after chlorination. The increase in the orthotolidin reaction is kept at the residual desired. This increase in fixed chlorine checks the dosage quite accurately on average results. Numerous inspections of the plants are made, the control of the operators is checked, and in many cases experimental absorption values for chlorine of the raw water are determined.

That control has been adequately maintained is shown by the general absence of B.-coli in the chlorinated water, at the larger plants in 100-c.c. quantities tested daily.

It is the policy of the department to chlorinate all surface waters at at least two points and to maintain 0.10 p.p.m. residual at one of these points. The Catskill supply is chlorinated during the summer as it enters Ashokan Reservoir, and the year round as it leaves Ashokan Reservoir, as it leaves Kensico Reservoir, and finally as it leaves Hillview Reservoir. At Ashokan Reservoir 0.05 p.p.m. residual is maintained, at Kensico 0.10 p.p.m., and at Hillview 0.05 p.p.m. If more than 0.05 p.p.m. is present at Hillview, particularly in winter, complaints of chlorine taste occur in the city. On the Croton system, Croton Lake water pumped to Catskill Aqueduct is chlorinated at Croton Lake, as is also the new aqueduct water. The new aqueduct is again chlorinated at Dunwoodie, maintaining 0.10-p.p.m. residual. The old aqueduct is chlorinated at Dunwoodie with 0.10 p.p.m. residual, and again at the 135th St. gatehouse in the city. The Long Island water is chlorinated at several points on the watershed and again at Ridgewood pumping station, maintaining 0.10-ppm. residual at all points.

To illustrate the bacterial efficiency of one of the largest plants, capacity 600 to 650 m.g.d., with maintenance of 0.10-p.p.m. residual chlorine, average bacterial results for two years are given in the accompanying table.

In all, 870 tons of chlorine were used by the city in 1932, in addition to 25 tons of bleach.

Work of the laboratory division

The fifth protection is the laboratory division, a force of six chemists, five bacteriologists, four laboratory assistants, five clerical workers and six laborers. In addition, two laborers are regularly loaned to the Ashokan laboratory. Three laboratories are maintained: Mt. Prospect, Mt. Kisco and Ashokan, the first located in the city, and the other two on the Croton and Catskill watersheds respectively. All sources of supply are regularly analyzed. Daily examinations from a physical and bacterial standpoint are made at twenty points, including certain taps in the city, the large chlorination plants and one of the sewage-disposal plants. Some 25,000 samples are analyzed yearly. Chemical and microscopical examinations are made at weekly or monthly intervals depending upon the importance of the source. The wells of private companies are included.

FIG. 3—DINOBRYON, a micro-organism that imparts a disagreeable fishy taste to the water. It is kept under control by treatment of the reservoir with copper sulphate or chlorine. This view is magnified 200 diameters.

FIG. 4—MICRO-ORGANISMS that impart disagreeable grassy, fishy or pig-pen odors to the reservoir water. There are included in this view (magnified 200 diameters) anabaena, aphanizomenon, dathrocystis and coelosphaerium.

Taste-and-odor and micro-organism control

So far, we have considered the protection of the supply from a sanitary standpoint. Nearly equally important do we consider the esthetic point of view, such as taste, odor, and turbidity. Taste from chlorine is controlled as has been described. Care is taken to prevent the introduction into the supply of those organic matters which may cause medicinal taste with chlorine, such as creosote, road oil and tar products.

Control of microscopic organisms is most essential to prevent taste. Regular weekly examinations for microscopic organisms are made in samples from all reservoirs on the watersheds and in the city, with samples from different depths near effluent gates, from aqueducts and from taps in the distribution system. Taste-producing organisms are usually not permitted to increase above 1,000 units per c.c., and Synura not at all. Chlorination will produce taste when organisms run between 500 and 1,000 units, and in such instances lower values must be maintained, particularly in water flowing directly to the distribution system. Synura is the worst pest, as the cucumber flavor and bitter taste are very persistent and may cause complaints even when in small numbers.

Chlorine at regular plants is increased at times to as high as 0.9 p.p.m. to control certain genera. Copper sulphate is applied to reservoirs by rowboat and by launch, depending upon the size of the reservoir. For many years we have applied copper sulphate by dry-feed to aqueducts upstate and to water flowing from one basin to another. At Ashokan Reservoir this has occurred as the water flowed through the dividing weir gate from the West to the East Basin, also to the aqueduct itself between Ashokan and Kensico Reservoirs. However, the latter treatment has rarely been necessary since chlorine has been applied to the effluent of Ashokan Reservoir. Prior to that time copper sulphate had been applied as much as six months in a year.

The latest development in combatting micro-organisms has been a plant at Muscoot Dam, a dam usually submerged half-way up Croton Lake. This plant was put in operation in 1931. Water is pumped from above the dam through a baffled box to which copper sulphate is dry-fed, and the solution is distributed

KENSICO CHLORINATION PLANT

	Raw Water		Chlorinated		Percentage Removal	
	1932	1933	1932	1933	1932	1933
Available chlorine applied:						
Theoretical, p.p.m.			.24	.26		
Analysis*, p.p.m.			.19	.19		
Bacteria per c.c., 37 deg. C.	16	16	3	2	81	88
B.-coli index per 100 c.c.	8	9	.01	.04	99.9	99.6

*Represents the chlorine applied at the time of sampling as determined by increase in fixed chlorine. The theoretical dosage is obtained from weight of chlorine used and flow measurement by venturi meter.

through a 1,000-ft. wooden-stave pipe fastened on the upstream side of the dam 9 in. below the lip. Orifices exist every 2 ft. Some trouble has been experienced due to stoppage of orifices by killed organisms. Nevertheless, the treatment, with a dosage averaging 1½ lb. per m.g., has been eminently successful.

In 1933, 76 tons of chemical were applied in this manner. At times taste-producing organisms entering the aqueduct at Croton Lake have been reduced by over 90 per cent and to less than 100 units per c.c. Comparing total counts at Muscoot Dam with Croton Lake effluent during 1931, 1932 and 1933, the reduction of all organisms has averaged 77 per cent, whereas it was only 39 per cent in 1928, 1929 and 1930. The latter figure represents effect of deep draft alone, whereas the former figure represents effect of deep-draft and copper-sulphate treatment. Undoubtedly the consumers have appreciated the better taste of the Croton water.

In addition to this Muscoot Dam continuous treatment, in 1933 the entire Kensico Reservoir was treated with 17.5 tons of copper sulphate at one time for Synura, a portion of Croton Lake was treated with 3 tons for an independent growth, and 21 other treatments of reservoirs were made. The total copper sulphate used in 1932 was 102 tons.

Illustrating specific use of chlorine to control microscopic growths there may be cited its application to the Massapequa infiltration gallery pumping station on Long Island in dose of 0.6 p.p.m. to destroy the Achlya fungus. The growth had been so heavy as to clog the screens at Milburn pumping station farther along the conduit, but it completely disappeared after several weeks.

Also, chlorine is regularly applied at numerous wells of the private companies in Jamaica and Flatbush to control iron bacteria such as Crenothrix and Spirophyllum, also the fungus Penicillium. In a few cases it is used to oxidize hydrogen sulphide. At several of the wells the chlorine is in the form of chloramine, in two cases due to the presence of free ammonia naturally present in the water to the extent of 2 to 5 p.p.m.

Problems resulting from turbidity

Not until the winter of 1926-1927 did serious trouble occur with turbidity in the Catskill supply. In November, 1926, there was a heavy downpour within a short period which averaged 4 in. for the entire Catskill Watershed and reached 7 in. in certain localities. It washed new channels in some of the creeks, exposed fresh surfaces of clay banks and caused very high turbidities. The colloidal turbidity was of such fineness, from 0.0002 to 0.001 mm., that it exhibited the Brownian movement under the microscope and required six months to settle in Ashokan Reservoir from 100-p.p.m. turbidity to one of 6 p.p.m.

The water was treated between Ashokan and Kensico Reservoirs and allowed to clarify while passing through the latter, a period of 2 to 3 weeks. Basic filter alum was fed at Pleasantville, a few miles above Kensico, by dry-feed to the aqueduct at a plant built for this purpose some years earlier by the board of water supply. Soda ash was also fed to the aqueduct at Ashokan Reservoir, about 24 hours prior to the alum. The alum floc with the entangled turbidity settled so completely in Kensico that tests of the effluent were negative for aluminum, even though some residual turbidity came through. The net result chemically was the presence of a few parts per million sodium sulphate in the water. Treatment started Dec. 9, 1926, and continued with alum to May 28, 1927, and with soda ash to June 3. Altogether 4,635 tons of alum were fed and 2,677 tons of soda ash. The turbidity of the effluent water from Ashokan Reservoir was at first 100 p.p.m. and decreased gradually to 6 p.p.m., and treatment was discontinued. With advent of warmer weather, the final turbidity settled rather suddenly. Dosage of alum ranged from 1.0 to 0.5 grains per gallon and of soda ash from 0.5 to 0.4 grains per gallon. A higher proportion of soda was fed toward the end due to increased complaints of red water in the city. The water in the city had a maximum turbidity of 7 p.p.m. It averaged 5 p.p.m. in January, 3 p.p.m. in February, 2 p.p.m. in March and later 1 p.p.m.

Since 1927 treatment for turbidity had taken place only for a few days or few weeks each year until the past winter. Three times last year treatment became necessary, from Jan. 20 to Feb. 8, from April 7 to 28, and from Aug. 28 through the winter and spring of the present year. During 1933 dosage of alum varied from 0.35 to 0.75 grains per gallon and half that amount of soda ash. Variation in dosage amounted to 0.10 to 0.15 grains per gallon of alum for the same turbidity depending upon its fineness and the temperature of the water. The turbidity ranged from 90 to 25 p.p.m. during the year 1933 with consumption of 3,715 tons of alum and 1,858 tons of soda ash.

The most serious turbidity was occasioned by a storm during the latter part of August, the heaviest on record, about 11 in. Owing to the depression, every effort has been made to use minimum dosage of chemicals. Examination of daily samples has been made for size of floc, alkalinity, pH, and turbidity of raw and treated water, turbidity in supernatant liquid each day after standing quietly for seven days, also turbidity on filtered samples of raw and treated water on the first day. It is astonishing how fine the adjustment must be. The pH and alkalinity reduction show that chemical action has taken place even when there is present no visible floc nor floc that will filter out. Under other conditions floc will be present and filter to zero turbidity, but yet will not settle. When dosage is adequate, the floc settles to low turbidity over night.

As we are dependent on settlement in a reservoir with low and changing temperatures and wind disturbance, good floc must be obtained. For example, untreated water of 9-p.p.m. turbidity retained 6 p.p.m. in the effluent of Kensico Reservoir, although it settled to from 2 to 3 p.p.m. in the laboratory in 7 days. We learned that it wasn't safe to trust surface samples, and samples were taken at various depths and at different distances through the reservoir. Increments of 0.05 grains per gallon of alum cause astonishing differences in character of the floc. Numerous laboratory experiments have been tried such as the use of sodium aluminate or kaolin, but with no benefit. It was also found that the floc, when adequate, was saturated with turbidity, so that the return of sludge would be of no benefit in reducing dose. Stirring will reduce effective dosage, as will application of alum prior to the alkali. Recently (about April 3) the use of lime hydrate was substituted for soda ash to reduce costs. It has been added at the Pleasantville plant but has given trouble with regard to even treatment of the water and has frequently prevented floc formation if the pH rose much above 7. It is probable that a separate plant will be needed below the alum plant for feeding lime, and possibly a mixing device if greatest efficiency and economy are to be obtained.

It is probable that future trouble with turbidity will increase rather than decrease, in which case it will pay to build a plant based on efficiency. Turbidity treatment has been mentioned in some detail since it is not usual to remove turbidity without the assistance of filtration.

The new Delaware supply that is planned will be of character similar to the Catskill water and will present similar problems, though it will be mixed with harder Croton water in one of the upper basins (West Branch Reservoir). It will also have opportunity again to mix with the Catskill supply in Kensico Reservoir.

The typhoid death rate for New York City was 1.0 for 100,000 population in 1933, and for the five previous years was 1.4, 1.2, 0.8, 1.1, 0.9 from 1928 to 1932. From a health standpoint alone there seems to be no reason to believe that filtration will be a necessity in the near future. If popular demand is made for filtration, it will be for some other reason, such as uncontrollable turbidity, taste or odor.

POLLUTION, TURBIDITY AND HARDNESS IN MID-WEST WATERS

TREATMENT PROBLEMS in the plains country involve difficulties because of the great variability in the quality of the waters —Groundwaters are hard—Surface waters turbid and polluted

By N. T. Veatch, Jr.
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MIDDLE-WEST water supplies are derived from many sources, and their quality varies quite widely. Surface supplies are usually subject to periods of high turbidity and are generally polluted to such an extent that they are unfit for domestic use without treatment. Groundwater supplies as a rule contain a large amount of mineral matter, but are ordinarily free from serious pollution.

In fact, the majority of the Mid-Western supplies are harder than the averages for the United States as reported by the United States Geological Survey (Water-Supply Paper 496). The survey lists surface supplies with 85 p.p.m. and groundwater supplies with 225 p.p.m.; all supplies, 99 p.p.m.

Table I shows approximately the number of public water supplies classified as to source in the sixteen states that make up the area commonly known as the Middle West. The data for nine of these states are fairly complete, but in the others numerous small supplies, principally from underground sources, are omitted through lack of available information. The general water-supply picture is shown by the fact that about 20 per cent of the systems, which serve approximately 70 per cent of the population, utilize surface sources. In other words, surface sources are utilized in general for the larger communities, while the smaller ones use groundwater. This emphasizes the limitations of groundwater supplies in this area.

Public sentiment is strongly in favor of groundwater, and many of the surface supplies have been adopted principally for the reason that they offer the only opportunity to get water in adequate quantities. The matters of hardness and cost of production and treatment, factors usually favorable to surface supplies, have not entered into the selection to the extent that is justifiable on an economic basis.

Hardness, after all, is a relative term, and during years of experience with hard water the average Mid-Western householder does not seem to worry much about it. In some rural sections the dividing line between hard and soft water is the edibility of beans that have been boiled in the sample in question. If the beans cannot be eaten, the water is hard and vice versa.

Surface-water supplies

Probably the outstanding quality characteristic of the water in Middle-Western streams is its variability. The fact that hardness often changes as much as 100 per cent, and turbidity 1,000 per cent in a period of a day, makes it impractical to express these characteristics by the results of a single analysis. Frequent and regular tests over a period of at least a year afford a fairly clear picture, but wide variations from the yearly average must be expected.

This variation is due to the "flashy" character of most of the Mid-Western streams, which are fed largely by runoff. The Marais Des Cygnes River in Kansas is typical of these flashy streams. Its observed flow at Ottawa, Kan., has varied from 0.5 to 16,900 sec.-ft., and the range between high and low stage exceeds 40 ft. The variation in hardness and turbidity is as follows: hardness, 100 to 350 p.p.m.; turbidity, 10 to 15,000 p.p.m.

In contrast to the flashy type, however, a few Mid-Western streams have fairly uniform flow and relatively uniform quality characteristics. Most of these are located in Michigan, Minnesota and Wisconsin, and are lake-fed.

The minimum observed flow of the North Loup River, for example, which is fed almost exclusively by drainage from the extensive "sand hill" area of North Central Nebraska, is about 65 per cent of the maximum. Turbidities rarely exceed 100, and the hardness of the water ranges from 150 to 200 p.p.m.

An unusually wide variation in hardness is shown by the Vermilion River in South Dakota. During the summer, when the flow is largely surface runoff, the total hardness is about 225 p.p.m.; but during the winter, when the flow is practically all groundwater seepage, a total hardness of 1,250 p.p.m. has been observed.

Impounded supplies, natural or artificial, are, in the main, subject to variations similar to those of the streams, but the range is naturally narrowed down by storage. It approaches that of the streams in small reservoirs and practically disappears in extremely large ones—as for instance, the great lakes.

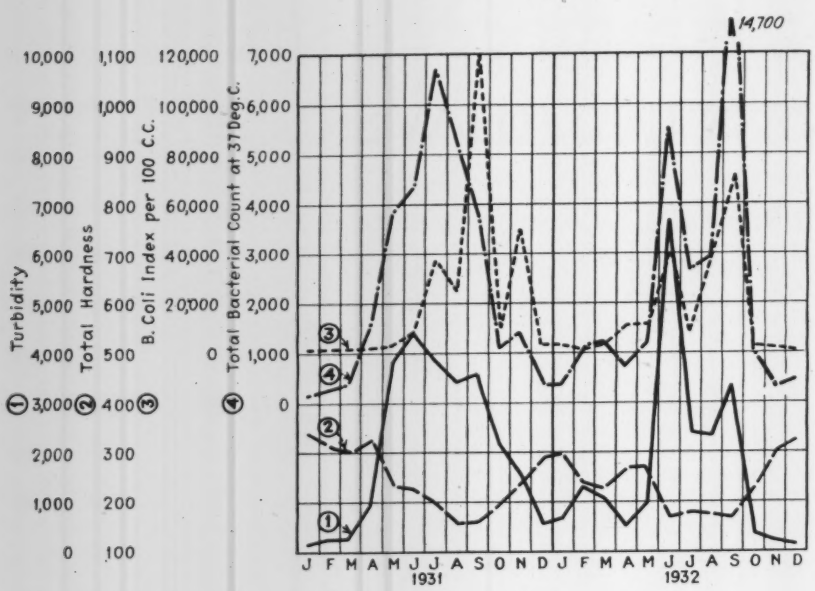
The supply for Oklahoma City, Okla., is taken from a relatively large artificial impounding reservoir on the Canadian River. The character of the water, as shown by daily analyses during the years 1932 and 1933, is as follows:

	Aver.	Max.	Min.
Turbidity, p.p.m.	110	8,000	25
Total hardness, p.p.m.	243	304	200

TABLE I — SOURCES OF MID-WESTERN WATER SUPPLIES

State	Surface Water Supplies		Groundwater Supplies		All Supplies	
	Number of Public Supplies	Population Served Thousands	Number of Public Supplies	Population Served Thousands	Number of Public Supplies	Population Served Thousands
*Michigan	70	2,646	80	593	150	3,239
Wisconsin	31	957	274	811	305	1,768
*Ohio	83	3,580	139	1,139	222	4,719
*Indiana	38	1,167	114	671	152	1,838
Illinois	92	4,493	353	1,248	445	5,741
*Kentucky	59	726	31	89	90	815
*Tennessee	26	396	68	438	94	834
Missouri	71	1,645	145	278	216	1,923
Iowa	35	316	482	971	517	1,287
*Minnesota	35	878	82	329	117	1,207
*North Dakota	9	71	19	57	28	128
South Dakota	14	46	174	202	188	248
Nebraska	9	237	299	463	308	700
Oklahoma	86	681	234	359	320	1,040
Kansas	53	420	235	512	288	932
Arkansas	18	203	62	201	80	404
Totals	729	18,462	2,791	8,361	3,520	26,823

*Data incomplete particularly in regard to small groundwater supplies but include practically all publi supplies that serve over 5,000 persons.



MONTHLY AVERAGE TURBIDITY, hardness, bacterial count and B.-coli index of Kansas River water at Topeka for 1931 and 1932.

The water from the Great Lakes, which afford what is probably the most generally satisfactory water supply in the Middle West, is relatively clear and probably does not depart more than 25 per cent from the following figures for hardness: Lake Erie, 125 p.p.m.; Lake Huron, 100 p.p.m.; Lake Michigan, 120 p.p.m.; and Lake Superior, 50 p.p.m.

Variability hampers treatment

The variable character of the surface waters of the Middle West imposes a number of special problems upon the treatment plants of this region. This is particularly true of the preliminary steps in the treatment process, since it is obvious that the peaks, particularly in turbidity, must be ironed out if the load on the plant is to be kept within reasonable limits.

The clarification of the Missouri River water at Kansas City, which at times carries as much as 18,000 p.p.m. of turbidity, involves the removal of as much as 21 tons of sediment (dry basis) per million gallons of water. Plant records showed that after the removal of some 94 per cent of this turbidity in the preliminary settling (grit) basins, the turbidity of the outgoing water was still in excess of 1,000 p.p.m., and it is evident that without special provision for handling this sediment the treatment process would be seriously handicapped.

The monthly average records of turbidity, hardness and bacteriological tests on the Kansas River water at Topeka have been plotted (see above), to show the range which must be met by the typical Mid-Western water-purification plant, and it should be remembered that the daily variations during the individual months complicate the problem still further. In 1930 the records of the Topeka purification plant show that the effluent was clear, had a total hardness of 83 and a B.-coli index of 0.05 per 100 c.c.

To summarize, the surface-water treatment problem in the Middle West may be described as relatively difficult, not on account of the fact that the water is not amenable to treatment but because of the continual watchfulness that its variable nature demands.

Groundwater supplies

The groundwaters of the Middle West are, as a rule, highly mineralized, although there are exceptional cases. The majority of them are amenable to softening, but a few contain so much sodium, potassium and permanent hardness that softening is impracticable except for laundry use. The occurrence of iron in objectionable quantities is quite general, and manganese has caused trouble in a few cases. Fluorides in an amount sufficient to be the undisputed cause of mottled enamel on the teeth of children is present in the water supplies of a few communities, notably Chetopa, Kan., and Bauxite, Ark.

Generally speaking, however, hardness is the principal objectionable quality of the groundwaters of this section. A large number of analyses taken from various publications have been assembled in Table II, to show the range of total hardness of these supplies. Naturally, this table is limited to supplies for which analyses are available, and it is not complete but is probably representative.

It is evident that the majority of the supplies exceed the average for those of the United States as quoted above, but it is a fact that, through the evident satisfaction of the users, only a relatively few are now being softened. Where softening or other treatment has been adopted, the urge has usually come from industrial users or has been the result of some particularly objectionable feature such as iron or manganese.

Lincoln, Neb., has experienced a considerable amount of trouble from manganese in a supply recently developed from the underflow of the Platte River, and bids are now being asked for the construction of a treatment plant. The quality of the water as disclosed during the tests leading up to the design of this plant is as follows:

	Aver.	Max.	Min.
Total hardness, p.p.m.	161	211	111
Iron, p.p.m.	0.33	0.50	0.26
Manganese, p.p.m.	0.45	0.60	0.25

Other constituents

The salinity of some of the Mid-Western supplies is also worthy of note. The supply for Wichita, Kan., which is obtained from the underflow of the Arkansas River contains an average of 390 p.p.m. and has a distinctly salty taste to one not accustomed to its use.

Hydrogen sulphide is present in a few supplies and is quite prevalent in southeastern Kansas. Quite often the users develop a liking for the water slightly flavored with hydrogen sulphide and chlorides and prefer it, as drinking water, to the unflavored kind.

In summary, the groundwater supplies of the Middle West may be classed as relatively hard and highly mineralized. Surface waters are, generally speaking, turbid and polluted. The water-treatment picture is characterized by the variety of processes required and by the need of close supervision, rather than by any particularly difficult feature.

TABLE II — RANGE IN TOTAL HARDNESS OF A NUMBER OF GROUNDWATER SUPPLIES IN SEVERAL MID-WESTERN STATES

State	Hardness Range, p.p.m.									Number of Supplies Considered
	Under 100	100 to 200	200 to 300	300 to 400	400 to 500	500 to 600	600 to 700	700 to 800	800 and above	
Ohio	1	2	10	12	2	1	1	0	2	31
Illinois	12	41	97	122	56	10	9	5	4	356
Missouri	5	35	41	27	7	3	2	1	0	121
Kansas	8	39	61	61	25	17	12	5	4	232
Arkansas	33	18	9	2	0	0	0	0	0	62
Iowa	1	9	28	39	13	7	6	4	22	129
Indiana	1	5	27	24	5	5	2	0	0	69
Oklahoma	2	7	9	11	7	5	2	1	10	54
Totals	63	156	282	298	115	48	34	16	42	1,054

ANOTHER GREAT LAKES CITY PLANS A FILTER PLANT

MILWAUKEE, preparing to join Buffalo, Cleveland, Detroit and other large cities on the Great Lakes in filtering its water supply, has started work on a 200-m.g.d. purification plant to be constructed on the shore of Lake Michigan

By L. R. Howson

Alvord, Burdick & Howson, Consulting Engineers, Chicago, Ill.

MILWAUKEE is building a water-purification plant. Its purpose is to eliminate turbidity, tastes and odors and to prevent gastroenteritis, which an exhaustive investigation indicates is closely related to the water supply. The decision to adopt filtration follows a quarter of a century of effort, during which succeeding sanitary engineers have advised the city to filter its water supply.

Involved in the plant are the following noteworthy features of design and construction. The plant is to be "cut in" on the Linwood Ave. tunnel while that tunnel remains in service. Mixing is to be accomplished by "flocculators," and subsequently the flow during coagulation and settling is to be through double-deck basins. Washwater drains are to be at the rear of the filters, saving space in the pipe galleries. Buoyancy is to be provided for by earthfill over the various basins. A single-sheeting breakwater out in the lake incloses the plant, which is located at the foot of a steep bank.

For the past 60 years Milwaukee has drawn its water supply from Lake Michigan, into which either directly or indirectly (through the rivers) the sewage of the community has also been discharged. The first intake extended into the lake one-half mile (see Fig. 2) in a southwesterly direction from the lake shore at the North Point pumping station and took water from a point about 2 miles away from the mouth of the Milwaukee River, through which most of the sewage pollution entered the lake. When this first intake was constructed, the population of Milwaukee was about 75,000. As the city grew, pollution increased, and the quality of the water secured from the intake became progressively worse. This condition led to the construction of the second North Point intake, extending 8,146 ft. straight east into the lake from the North Point station. This intake, taking water from a point 3 miles from the river mouth, was placed in operation in September, 1895, when the population had grown to 250,000, and it remained in active use for more than twenty years.

As time passed and the city expanded in area, population and industrial development, the influence of pollution was felt more and more frequently at the intake. Accordingly, in 1918 when the population had reached 440,000, a third intake was built, to take water from the lake a little more than 4 miles from the river mouth. Tunnels were constructed from the shore shaft of that intake to the North Point pumping station and to the new Riverside station constructed on the Milwaukee River bank, 2 miles west of the lake shore. Since 1918 the North Point intake has been held in reserve.

Even prior to this last tunnel construction, engineers who had studied Milwaukee's water supply and sewerage problems were convinced that the city could not long secure anything like a satisfactory water supply by simply building intakes farther out into the lake and by sewage-treatment measures. However, the divergence in viewpoint locally on this matter led to the construction of the Linwood Ave. intake and the further postponement of filtration works.

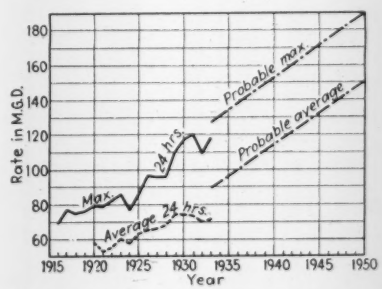


FIG. 1—DAILY PUMPAGE of water in Milwaukee, past and probable future to 1950.

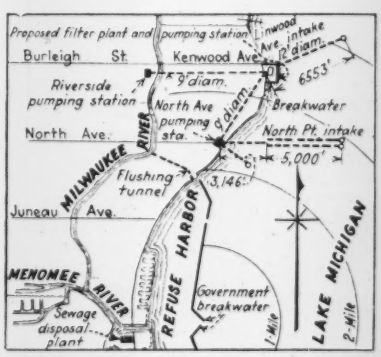


FIG. 2—LOCATION of filter plant on lake shore at inshore end of Linwood Ave. tunnel.

Prior Studies at Milwaukee

The first comprehensive investigation of the allied problems of sewage treatment and water purification at Milwaukee was made in 1910 and 1911 by a sewerage commission consisting of Alvord, Eddy and Whipple. This commission recommended that construction of filters be undertaken immediately. Other investigations followed, including those of Dr. A. J. McLaughlin; H. P. Letton, of the U. S. Public Health Service; Joseph W. Ellms, who conducted an experimental plant over an extended period and made an exhaustive report to the city; R. E. Tarbett, of the U. S. Public Health Service; Harrison P. Eddy and H. W. Streeter. All of these investigations led to the same conclusion—namely, that the most effective means of safeguarding the purity of the municipal water supply was through the construction of adequate filtration works, and that the construction of filtration works should be undertaken promptly.

1933 Schwada report

Beginning in 1926 and continuing to date, the city engineering department, under the direction of Joseph P. Schwada, has been studying the matter of additional capacity and the improvement of quality of the water supply. Extensive studies of the quality of the water along the entire lakefront have been made; analyses of wind and lake currents and velocities, the combination of conditions which have resulted in lowering the quality of raw water supply, and other factors indicating the effect of the water quality upon health were carefully analysed. The results of this extended investigation were incorporated in a comprehensive report pre-

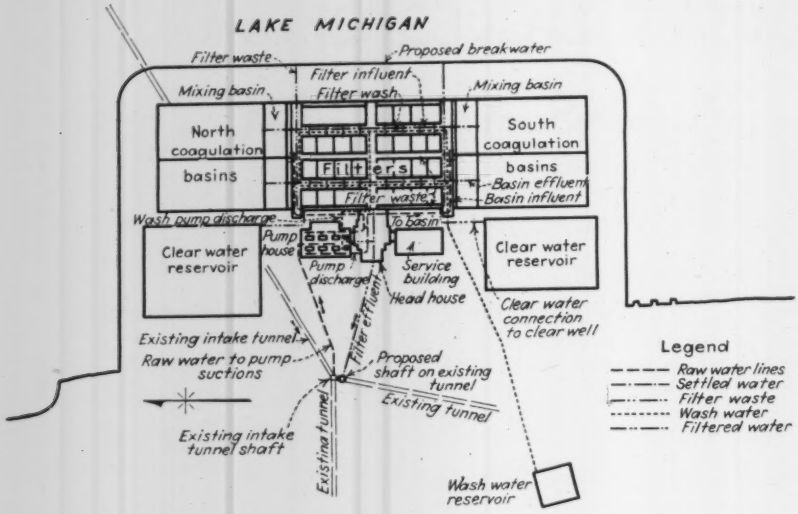


FIG. 3—MILWAUKEE PURIFICATION PLANT is located on Lake Michigan shore behind breakwater. Filters are in center with coagulation basins on either side and filtered water basins inshore. Future units can be extended into lake in three directions.

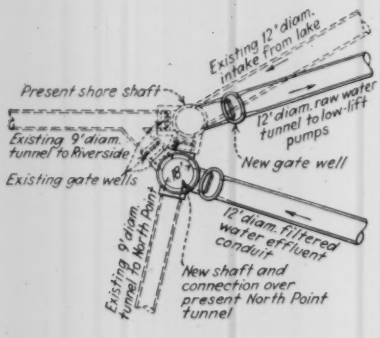

Existing 12' diam. intake from lake
Present shore shaft
12' diam. raw water tunnel to low-lift pumps
Existing 9' diam. tunnel to Riverside
New gate well
Existing gate wells
12' diam. filtered water effluent conduit
Existing 9' diam. tunnel to North Point
New shaft and connection over present North Point tunnel

FIG. 4—A NEW SHAFT will be sunk over the existing intake tunnel to deliver water to the low-lift pumps.

pared by Mr. Schwada and were presented to the city council in February, 1933, the report being designated "Report on Safeguarding and Improving Milwaukee's Water Supply with a Water-Purification Plant."

In this report, in addition to showing what filtration would do toward the removal of turbidity, the prevention and elimination of tastes and odors now occasionally present in the supply, Mr. Schwada outlined the practical limitations to chlorination in protecting the safety of the water supply and developed in great detail the relation between gastroenteritis and the quality of the water supply. Mr. Schwada's report concluded that water filtration was necessary if Milwaukee was to have a safe, palatable and attractive water supply conforming to present-day standards.

This report immediately received the attention of various civic organizations in addition to that of the city council. Agitation for the carrying out of the report's recommendations became active.

In June, 1933, the city council passed a resolution authorizing the city engineer to employ Alvord, Burdick & Howson as consulting engineers to assist in the development of the plans for filtration works and in their presentation to the PWA in the city's negotiations for a loan and grant for the construction contemplated.

Preliminary layouts were prepared, estimates were made, and preliminary drawings, general specifications and estimates of cost were completed in July and presented to the PWA which approved the project for a loan and grant of $4,600,000 and entered into contract for furnishing the money late in 1933.

General features

Milwaukee has enjoyed a gradual consistent growth in population and in water consumption for the last several decades. It was one of the first of the larger cities to meter its supply, and the growth in water use has accordingly approximately paralleled the growth in population.

Fig. 1 shows the growth in pumpage for the average day and for the maximum day during each of the several years recently past, together with a forecast of the probable requirements until 1950. With adequate clear-water storage, filtration-plant capacity is usually provided to meet the requirements of the maximum day, the peak hourly fluctuations being met from stored water. In the belief that the present construction should be adequate for the next fifteen years, the plant now being designed will have a nominal-rate capacity of 200 m.g.d.

The plant site is located where the Linwood Ave. tunnel crosses the Lake Michigan shore line. On account of the steep bank at that point, the plant must be constructed on made land. The plans provide for a breakwater and revetment wall entirely inclosing the site, extending out into the lake from 700 to 1,000 ft. and for a distance north and south along the lake shore for approximately 1,400 ft.

Provision is being made for taking raw water from the Linwood Ave. intake shore shaft, passing it through the various steps of filtration and then discharging on the land side of the shore shaft into the tunnels leading respectively to the Riverside and North Ave. pumping stations. These tunnels will operate under head instead of under suction lift as at the present time.

The low-lift pumping equipment will be located in the north wing of the main building. It will consist of five units, each of 50-m.g.d. capacity, set in pairs so as to take suction from a vertical riser from the tunnel, which extends under the entire building. The pumps discharge into duplicate raw-water headers, one leading to the north and the other to the south coagulating basin.

From this point the filter plant in effect consists of four 50-m.g.d. units, each consisting of a mixing and reaction chamber of 60 min. detention period, followed by four hours of coagulation and settling capacity before going to the filters. Each battery of filters consists of eight units, each of 6.25-m.g.d. capacity.

The clear wells have a total capacity of approximately 30 m.g., of which two (7.33 and 9.65 m.g. respectively) are separate earth-covered structures located in front of the main building, and the third (12.65 m.g.) is located under the filters.

Although the design is in progress at the present time and many of the plans tentatively decided upon may be modified during the later progress of the work, some of the design features involve construction of rather unusual type.

Connection to existing tunnel

One of the items which has received a large amount of attention is that of the most practicable method of connecting to and utilizing the existing tunnel facilities. At the present time the design has been narrowed down to two alternatives, the most likely one of which is shown on Fig. 4. The 12-ft.-diameter Linwood Ave. intake tunnel from the lake terminates at a shore shaft from which radiate two 9-ft. tunnels to the Riverside and North Point pumping stations respectively. At the time this construction was made, three gate wells were constructed, two for the purpose of shutting off either of the stations and tunnels, and the third on a stub end for a possible cross-connection between the two tunnels if required at a later date.

The plan on Fig. 4 contemplates the closing of two valves in the North Point tunnel line, one located at the shore shaft of the Linwood tunnel and the other at the North Point station 1½

miles away. The North Point tunnel will then be dewatered. A new shaft 18 ft. in diameter will be constructed over the North Point tunnel 20 ft. south of the Linwood Ave. shaft. Connection will be made to the bypass between the Riverside tunnel and the North Point tunnel, and a 12-ft.-diameter filtered-water effluent conduit with its gate well will be constructed between this shaft and the clear wells. There will also be constructed a 12-ft.-diameter raw-water tunnel leading from the outside of the existing Linwood Ave. shore shaft to the low-lift pumps. When the time comes to connect this tunnel to the shore shaft, it is planned to slide a steel liner inside the shaft and calk a tight joint between the liner and the shaft walls, the liner to extend to a point below the raw-water tunnel connection—that is, 40 ft. below lake level. This will make it unnecessary to dewater the shaft and will also insure against leakage in the valves. The calking will be done by divers.

During the time that the connection of the raw-water tunnel to the existing shore shaft is being made, water for both the North Point and Riverside stations will be drawn through the North Point intake, the Riverside station water bypassing the Linwood Ave. shore shaft through the new bypass connection.

After the raw-water tunnel connection is made to the shore shaft, the steel liner will be pulled, the connections between the shore shaft and North Point and Riverside tunnels will be permanently plugged, and thereafter there will be no connection between the raw lake water and the filtered water in the tunnels from the shore shaft to the pumping stations.

Plant arrangement

The general plant layout, as outlined in Fig. 3, has been determined upon and is definite. The entire design is practically symmetrical about a central east and west line, passing through the headhouse and the central pipe gallery.

Washwater storage is provided in a 750,000-gal. reinforced-concrete reservoir located on the bluff in the park, 700 ft. from the filters. Connection is provided through a 60-in. main. Washwater is pumped to the reservoir by two 20-m.g.d. motor-driven pumps, taking suction from the clear-water reservoirs.

Each of the two low-lift discharge lines passes vertically under the headhouse in which the chemicals are stored, measured and applied. A feed well is provided on each line.

Provisions are made for feeding ammonia in the pump suction line, for feeding chlorine, alum, lime and carbon at the feed wells under the headhouse, for activated carbon at the outlet of the coagulating basins just prior to filtration and for the application of both ammonia and chlorine in the filter-effluent line as the water passes to the clear-water reservoirs and thus to the pumping stations, 1½ to 2 miles away. Flow through the tunnels provides a convenient reaction period for the chlorine and ammonia. Provision is also made for feeding lime at the inlet of the mixing basins, should softening be desired at a later date.

The mechanical mixing facilities consist of equipment of the flocculator type located near the entrance to the coagulating basins. The space occupied by the flocculators is equivalent to 60 min. of the settling-basin period. The water is admitted to these basins through an inclined slot in the top of the raw-water conduit in order to effect equal distribution across the 150-ft. width of the tank. The flocculating equipment will be in two rows, each consisting of nine units, each 20 ft. in diameter. Flocculator shafts are separated 32 ft. apart.

After passing the second row of flocculators, the water flows to a settling and cogulating basin of the two-story type. Originally it was planned to use single-story around-the-end basins. This, however, on account of the low elevation of the ground surface (5 to 6 ft. below lake level) and the necessity for a water-surface elevation of 22½ ft. above lake level, required either supporting the entire structure on piles or on hydraulically placed and confined sand fill, or the construction of excessively deep basins. In order to decrease the expense and to secure the desired water level in the coagulating basins without excessive depth, the two-story type of construction was adopted. The water will flow through the lower compartment first, then back through the upper compartment, through the collecting trough and thence to the filters. The settling period is four hours. The water will pass from the lower to the upper compartment of each of the four settling basins through nine 3x3-ft. openings, one located in each floor panel. The velocity of flow through the openings will be slightly less than 1 ft. per sec. at rating. Most of the settling will normally occur in the lower settling compartment.

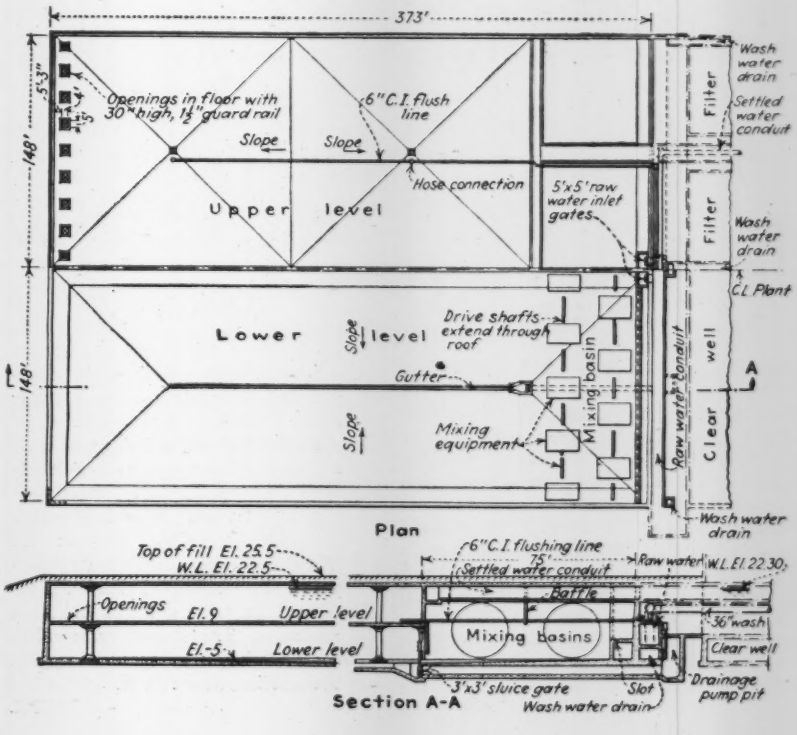
The middle floor is being designed to carry 200 lb. per sq.ft. Drainage and automatic openings are provided to prevent overloading when the water in the basin is drawn down. The bottom floor is being designed for 56.2 lb. per sq.ft. upward pressure.

Provision is being made for the use of lime if and when necessary during periods of heavy microscopic growths or for softening if desired at a later date. With that in view, the design of the coagulating basins is such that drag-line equipment for continuous sludge removal can be installed in the lower compartment.

Filters

Each filter unit will have a capacity of 6¼ m.g.d. at a rating of 2 gal. per sq.ft. per min. The filter units will be of the central-gullet type, consisting essentially of two 3⅛-m.g.d. units, except for inlet and effluent piping. Washwater

FIG. 5—DOUBLE-DECK shallow coagulation basins with flocculators at inlet end conserve space.



connections and troughs are being designed for a 36-in. vertical rise. Consideration is being given to auxiliary methods of surface wash and to modifications of standard perforated pipe collecting and distribution systems.

The arrangement of washwater waste is a departure from ordinary practice in that the waste sewer is located at the rear of the filters instead of in the pipe gallery, thus effecting a material saving in piping as well as making practicable a more open and unobstructed pipe gallery design.

At the present time Lake Michigan is substantially at the lowest level on record, about 3.5 ft. below Milwaukee datum. A lake elevation of +3 ft. is not uncommon. As the bottoms of the principal structures are at elevation —5 ft., they must be designed against upward pressure in excess of 500 lb. per sq.ft. In order to provide weight to counteract buoyancy, the clear wells are to be covered with 3 ft. of earth and the coagulating basins with 2 ft. of earth.

Borings have shown that there is not much likelihood of piling being required under any of the structures. Materials encountered are a dense clay, in general becoming harder with depth, overlaid by a deposit of boulders and coarse gravel, usually only one or two layers in depth.

Breakwater construction

On account of the large number of boulders on the lake bottom at the site, it was decided, preliminary to the design of shore-protection works, to let a contract for driving a test section of breakwater. An appropriation of $7,500 was made, and contractors were requested to state how many linear feet of breakwater construction of specified types they would drive for the money available; 85 ft. were thus constructed. During this construction the city kept a record of the number of blows per foot of penetration for each wood pile and for each of three types of steel sheeting. The information thus secured demonstrated the practicability of driving sheeting, and furnished the basis for the design subsequently adopted. The number of blows per foot of penetration increased very rapidly after a depth of 6 ft. was reached, and accordingly that was the limit specified on the breakwater construction.

In view of the necessity for inclosing the site before construction work on buildings could get under way, the first detailed plans other than for the washwater tank were prepared for the shore-revetment works. Bids were first taken upon a heavy double steel sheetpiling bulkhead, with the inside of the bulkhead filled with stone and capped with 3- to 5-ton stone blocks, and extending easterly into the lake about 400 ft. beyond the limits of the present building construction. However, bids taken upon this plan resulted in figures higher than the preliminary allowance for shore-protection work. Accordingly these bids were rejected and a redesign made, using a single-sheeting breakwater with stone backing and toe-and wood pile anchors at 5-ft. centers, and with the location drawn in to a point 100 ft. lakeward from the building. Bids were well within the estimated cost.

Personnel

The work is being done under the general direction of J. P. Schwada, city engineer, with H. H. Brown, engineer in charge and H. C. Schmitt, engineer of construction. R. E. Stoelting is commissioner of public works. Outline and general-dimension drawings are being prepared by Alvord, Burdick & Howson, with advice on certain special features from Charles P. Hoover and John R. Baylis. The consulting service carries through the design, construction and early operation periods.

WHAT THE DEPRESSION DID TO DETROIT'S WATER FINANCES

PROBLEMS arising from doubling the debt in previous decade for a needed new supply struck the department with full force at the beginning of the depression—Financial stability now returning

By C. W. Wright
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IF EVER a city water department descended into the abyss of a depression, Detroit's did about a year ago. The outside world heard of the debt defaults and the wholesale dismissal of employees, but details were lacking. Exactly what happened? In the following article Mr. Wright calmly recounts the harrowing experiences of a municipal utility squeezed between increased debt charges and decreased revenues. The climax came when the city's banks collapsed. Happily, the tide has now turned.

—EDITOR.

LARGE EXPENDITURES for a waterworks expansion program, made necessary by the rapid growth of the city, caused the Detroit water department's debt to double within a decade. Then came a decreased income period. The city's difficulties were aggravated by its inability to collect frontage assessments for new mains. Next came bank failures that tied up consumer and city funds alike. At the bottom of the depression the water department had accumulated a maximum delinquency of $1,150,000. Wholesale dismissals of staff followed. Operation was cut to the bone. Finally, through a judicious collection policy, a gradual industrial recovery and participation in the city's bond-refunding operations, the department is well on the road back to normal conditions. An account of the critical financial experiences of Detroit as it passed through the various stages of the depression is the theme of this article.

During the nine years from 1923 to 1932 the Detroit water department was engaged in a program of expansion involving the expenditure of $85,000,000 on capital items. Of this amount $28,000,000 was for improving the existing supply works and the complete construction of a new pumping and filtration plant. The balance was for the extension of mains, the installation of new services and meters, the erection of elevated storage tanks, the construction of a new office building and other expenditures required by a city that had increased its area from 84 square miles in 1923 to 138 square miles in 1927, and its population by 400,000 people.

By 1920 the Board of Water Commissioners had realized that considera-

tion must be given to the securing of an additional supply of water. Separate studies and reports were made on this subject by several engineers. Following the presentation of these reports, a consulting board in December, 1923, was appointed to recommend a comprehensive plan for the construction of an additional water supply. As presented, the plan was adopted by the water board in January, 1924. In the early part of 1925 a division of engineering was organized especially for the purpose of making studies and investigations, preparing plans and supervising the construction of the additional supply.

The work undertaken divided itself into three parts, namely: the improvement and extension of the Water Works Park plant by the replacement of pumps and by increasing the facilities for the storage of filtered water; the construction of additional force mains, booster stations and elevated storage to permit the Water Works Park station to operate to the best advantage; and the construction of the new Springwells plant in the western part of the city, consisting of low- and high-lift pumping stations, filtration plant, filtered water storage and power plant, together with a tunnel across the city and an intake in the Detroit River at the head of Belle Isle.

Increased debt, decreased revenue

To finance this program, the voters in the fall of 1926 authorized a $30,000,000 bond issue, and this amount was added to the bonded debt of the department between 1928 and 1931. This resulted in the annual interest on the debt increasing from $1,496,565 in 1928 to $2,817,737 in 1932. The requirements for bond retirement also increased about a half million dollars per year during the same period. Operating costs were higher than in 1928 and reached their peak in 1930. This was also the high year for water revenue.

Previous to 1931 the earnings of the department after paying operating expense were reinvested in the plant. Much of this money was expended for the installation of service mains in the newer sections of the city. While a city ordinance provides for the levying of an assessment against abutting property for the construction of such mains, even if completely collected, these assessments would pay only one-half of the actual costs. Under the original ordinances, which provided for assessments for laying mains, the only means of forcing payment was by refusing a tap until the assessment was paid. A new ordinance, passed in 1926, provided for the rewriting of the old rolls and the collection of the delinquent assessments in the same manner as for all past due taxes at a tax sale.

As a result of the decrease in income after 1930, a special effort was made to complete the rewriting of these assessment rolls and to send them to the city treasurer for collection. During 1931 and 1932 nearly $780,000 in assessments was prepared for collection, and at the present time there is less than $500,000 outstanding. How soon this can be collected is problematical, as there is no market at present for delinquent taxes.

In addition to the installation of the smaller mains, the department laid large transmission mains, varying in size from 24 to 72 in. Many of these were not entirely needed at the time but formed a part of the ultimate transmission system. The work was started in the fall of 1928 to take advantage of a period of low prices and thus effect an ultimate saving to the department, and at the same time to furnish employment to men who, because of industrial inactivity, would otherwise have been idle.

This work continued through 1930, and during the early part of that year the use of hand labor was instituted almost entirely as a means of helping the unemployment situation. It is estimated that a saving of about $900,000 would have been made had this work been completed with machines; and if the mains not required at that time had not been laid, the capital expenditures undertaken would have been reduced by about $2,250,000.

These facts are recorded to show the enormous expenditures for plant during the last ten or twelve years from the surplus of the department and from the sale of bonds. Yet, the increased fixed charges would have been met in a satisfactory manner had it not been for the depression with its resulting unemployment from the closing down of building construction, the closing of factories and small commercial enterprises and, finally, the closing of banks with the resultant tying up of the liquid assets of many consumers.

Water consumption

From the accompanying table of consumption it is noted that there was a steady increase in the use of water until the fiscal year ending June 30, 1930.

The course of water consumption of manufacturing, commercial and domestic users since Jan. 1, 1929, is given in the accompanying table. It will be noted that the greatest decline has been in the water used for manufacturing purposes. The decrease in the use of water for commercial purposes has been fairly uniform.

Domestic consumption has shown little change. The average quarterly consumption per account is also given in this table, and it shows that the use of water for all classes of consumers has been on the upturn during the first three quarters of the persent fiscal year.

Delinquent accounts

Probably the most serious situation this department faced during the depression was the problem of delinquent accounts, which from 1931 to the middle of 1933 had increased at an alarming rate. Foreclosures on property, bankruptcies, closing of banks, unemployment and the general inclination of many people not to pay any bills until forced to do so were the prime causes of delinquency within the city. However, the major portion of these accounts will be collected eventually, as water bills are liens upon the properties served.

Outside Detroit, water is sold to 21 cities and villages and to several unincorporated areas. Fifteen of these com-

CLASSIFICATION OF SALES OF WATER AS TO CLASS OF CONSUMERS*

Manufacturing Consumption, in Cubic Feet

Period	Consumption	Average Quarterly Consumption per Account
2 quarters ending June 30, 1929	1,131,919,600	308,173
4 quarters ending June 30, 1930	2,095,621,600	284,075
4 quarters ending June 30, 1931	1,631,319,900	221,526
4 quarters ending June 30, 1932	1,570,900,600	213,391
4 quarters ending June 30, 1933	1,313,961,500	180,439
3 quarters ending Mar. 31, 1934	1,222,618,200	230,784

Commercial Consumption, in Cubic Feet

Period	Consumption	Average Quarterly Consumption per Account
2 quarters ending June 30, 1929	1,201,929,800	26,157
4 quarters ending June 30, 1930	2,538,700,100	27,528
4 quarters ending June 30, 1931	2,317,620,900	24,527
4 quarters ending June 30, 1932	2,128,231,600	22,536
4 quarters ending June 30, 1933	1,854,252,300	19,932
3 quarters ending Mar. 31, 1934	1,481,888,700	21,474

Domestic Consumption, in Cubic Feet

Period	Consumption	Average Quarterly Consumption per Account
2 quarters ending June 30, 1929	1,483,896,700	3,263
4 quarters ending June 30, 1930	3,336,522,500	3,597
4 quarters ending June 30, 1931	3,460,907,400	3,641
4 quarters ending June 30, 1932	3,454,431,300	3,595
4 quarters ending June 30, 1933	3,228,254,800	3,350
3 quarters ending Mar. 31, 1934	2,645,529,200	3,663

*Suburban districts not included.

WATER CONSUMPTION

Fiscal Year Ending June 30	Total Gallons	Average Daily Gallons
1925	68,533,140,500	187,762,028
1926	73,494,870,050	201,355,812
1927	77,359,362,750	211,944,254
1928	78,060,247,750	213,279,365
1929	91,025,373,500	249,384,585
1930	94,184,421,500	257,942,694
1931	87,228,072,250	239,455,326
1932	80,741,775,350	220,605,944
1933	75,256,491,300	206,182,168
1934 (Apr. 30)	69,791,694,550	226,577,943

munities buy water wholesale and operate their own departments. The other six and the unincorporated areas contain about 8,000 customers who deal directly with this department. The communities which buy water wholesale from Detroit have also been faced with problems of delinquent customers, decreased tax collections and closed banks, one of them having had its surplus completely wiped out on two different occasions.

In several instances it was found that water revenue has been used to maintain the general city government. This has resulted in a number of these accounts also becoming delinquent. The water board has cooperated with these municipalities in caring for their back bills by allowing payment in installments over a period of four or five years.

New collection policy

With the increase in delinquency, the board recognized its obligation to the community and realized that many, through no fault of their own, were unable to meet their bills. It was evident, therefore, that a collection policy was needed that could be carried out with a small staff, that would cause no undue hardship to delinquent customers, that would insure proper and uniform treatment to all customers in the same class and that would insure collection from all who could pay.

A policy that would meet these requirements was adopted in January, 1932. Routines to carry it out were designed and put into immediate operation, but failed to halt the constant advance of the delinquent balance. This was not so much due to any fundamental weakness of the plan as to the fact that the economic conditions in Detroit were steadily getting worse.

Then came the closing of the banks in February, 1933, with results that are known to all. The delinquent balance chart shown elsewhere in this article illustrates clearly the effect of the closing of the banks on collections. Little could be done toward reducing the delinquent balance while the banks were closed except to plan ways and means of making collection after they opened. This was done, and the following conclusion was reached:

"That the Detroit department of water supply is a branch of the city government that operates solely for the purpose of furnishing its citizens with an adequate and dependable supply of pure water. It operates without profit, and its only revenue is that derived from the sale of water. Its rates do not provide, nor were they intended to provide, a reserve for bad debts. Theoretically, the department must collect in full for service rendered or run into a deficit. It is not a charitable organization, nor can it function as such either legally or practically."

It was realized that it would be impossible immediately to clear all accounts on which a delinquent balance had been allowed to accumulate, but that the increase in delinquency could be immediately stopped by requiring each delinquent customer to pay on account an amount equal to the current bill.

It was also realized that there were many who would be unable to meet this requirement. It was feared that the operation of this rule might lead to serious consequences, so a meeting was held with the department of health and the department of public welfare, and the previously mentioned rule was adopted and put into immediate effect with the understanding that any customer who was deprived of a water supply could appeal to the board of health, which would investigate the case and force payment wherever possible by application of the provisions of the sanitary code.

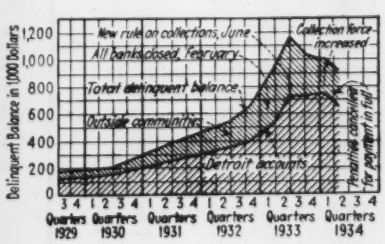
In those cases where investigators were unable to locate any legally responsible party who could pay and where the lack of water service was causing a health menace they would refer the case to the department of public welfare, together with their findings and recommendations, after which the department of public welfare would pay out of welfare funds the amount required to have service resumed. This does not apply to regularly enrolled and approved welfare families, as their bill is paid by the welfare department before the cut-off.

This rule did not change our previous plan except as it established a minimum partial payment below which our credit bureau could not go

Delinquencies halted

With the adoption of this plan about June 1, 1933, the rise of the delinquent balance was stopped. Early in 1934 the economic condition in Detroit showed definite signs of improvement. It was thought that the time had arrived to bear down. The collection force was increased, with such gratifying results as are shown in the accompanying chart.

As a further inducement to delinquent customers, the department agreed to



DELINQUENCIES in Detroit water bills rose to a peak in June last year. The institution of new rules in regard to collections halted the climb, and at the present time the unpaid bills are being rapidly paid off.

cancel all accrued penalties, provided that the account was promptly paid in full or a partial payment agreement was signed. This offer became effective May 1. The newspapers gave it publicity, and a notice of the special offer was attached to all current bills sent out that were carrying an item of arrears.

The response to this offer has been gratifying. During the first eight days of its operation 1,145 delinquent accounts were completely cleared. In addition to this, 450 of the delinquent customers have signed a partial-payment agreement.

Operating costs cut

Efforts were made during the early part of 1932 to reduce operating costs wherever possible. Construction work nearly ceased, and maintenance work was reduced materially. The number of employees occupying salaried positions was reduced nearly 50 per cent. Effective Jan. 1, 1932, all salaries in all city departments up to $4,000 per year were reduced 10 per cent. Those receiving above this amount were reduced an additional 10 per cent on all amounts above $4,000. During May and June of that year only 50 per cent of all salaries were paid. Following this, in July, 1932, the Common Council passed an ordinance which shortened the working week to five days, resulting in an additional 14½ per cent reduction in salaries.

Because of the closing of all of the banks in Detroit on Feb. 14, 1933, most of the departments of the city, including the water department, ceased making payments of interest, sinking-fund and principal charges on bonds. During the rest of that fiscal year, which ended June 30, 1933, the board, after meeting maintenance and operating charges, paid in full all outstanding notes, trade acceptances and current obligations.

Refinancing

At the present time a plan has been completed by the city of Detroit for refinancing past-due obligations and those coming due during the years immediately ahead. The effect upon the water department will be to issue a series of refunding bonds for all those bonds maturing on or before June 30, 1940, the new bonds maturing 30 years from date of issue.

Another series of bonds to be issued will refund over a period of about 30 years some outstanding notes that were issued in anticipation of the sale of water bonds. Accumulated interest upon outstanding bonds and notes has also been refunded. All payments that became due under the refunding plan since July 1, 1933, have been met in full. The water plant as present has a valuation of $116,000,000, against which there is a long-term debt of $63,000,000 outstanding.

RATIONAL RATE STRUCTURES FOR MUNICIPAL WATERWORKS

BASES for equitable rates re-examined in the light of requirements to make revenue bonds eligible to receive PWA consideration—A rational determination of the relative shares to be borne by the individual consumer and by the community at large

By Arthur W. Consoer

Consoer, Townsend, Older and Quinlan Consulting Engineers, Chicago, Ill.

THE ADVENT of the Federal Emergency Public Works Administration has focused attention on the profit-making possibilities of municipal water-supply installations and has intensified the development of rational and equitable rate schedules for water-supply improvements which are to be financed from revenue. Noticeable also is the keener appreciation of the value of definitely segregating water revenues from tax revenues, also a recognition of the necessity of good accounting and improved administration of water department operations. Furthermore, interest has been aroused in long-range planning of comprehensive construction policies for water-supply systems. Along with these developments has occurred an insistent demand for new and improved legislation to authorize the issuance of water-revenue bonds, which will be approved by nationally known and accepted legal counsel.

Effects of PWA standards

Important clauses for such water revenue-bond statutes have been developed as a direct result of the excellent critical methods of analysis developed by the PWA financial, legal and engineering examiners. These concern a definite requirement for segregating a sufficient proportion of total revenue to care adequately for interest and amortization charges and also a mandatory clause requiring an increase in rates whenever the cash receipts are not sufficient to cover both fixed charges and operating expenses. As a representative of municipal applicants to PWA, it has seemed rather clear to the writer that, to gain PWA approval on water-supply projects to be financed from revenue, the probable revenues, with reasonable rates, should be sufficient to cover fixed charges and operating expenses at least 1½ times. It would be helpful to future applicants on such matters, as well as to investment bankers and bond buyers, if PWA would announce any standard procedure that may have been developed by its competent staff of examiners in determining the desirable percentage of coverage of income over outgo and in determining the reasonableness of rates.

Many desirable changes in water-revenue laws have become apparent as a result of the test put to such laws by the PWA examiners. A number of such statutes permit the construction of new water-supply works or improvements to them with an original issue of such securities but do not permit the issuance of new bonds for additions or improvements when there are outstanding bonds. In other cases the refunding of outstanding bonds is desirable but cannot be carried out under existing laws. Again, the water-revenue bonds constitute a good first-mortgage lien on the waterworks property but do not carry with them franchise provisions in the event of default. Out of all the examinations made by PWA on water-supply projects to be financed by revenue there should come an excellent water-revenue bond law. Such a law could be developed in any certain state after examining all of the objections raised by the PWA to water-revenue projects filed in that state, or perhaps out of the PWA organization itself will come a model water-revenue bond law.

When properly protected by a suitable water-revenue act and by adequate examination of engineering, legal and financial features, water-revenue bonds should sell readily at all times and at attractive rates in the bond market. In communities where tax delinquency is considerable or uncertain such bonds should be preferred to general obligation bonds. In at least one case the PWA expressed a preference for water-revenue or mortgage bonds over general obligation bonds on a large water-supply installation. In passing, it might be noted that the same advantages can be developed for sewer-rental bonds.

New Field for Engineers—Engineers and officials alike are looking forward to the time when investment bankers and bond buyers will become actively interested in purchasing water-revenue bonds and sewer-rental bonds, because of the effect such interest will have in the development of construction programs for water-supply and sewerage improvements. When that time comes, if it is not already here, the bankers should, in the light of principles being advanced by the PWA, obtain reports on all such projects from competent "examining engineers." Many of the men trained in the intricacies of PWA procedure by the preparation of loan applications during the past year will be good recruits for such a group.

Recent estimates indicate that in the United States water-supply improvements are needed estimated to cost $600,000,000. Much of this work can be financed with water-revenue bonds. The importance of this fact can be realized when it is known that private financing for capital or durable-goods industries has shrunk from an average of four billion dollars each year in the ten years prior to 1930 to $160,000,000 in 1933, or about 4 per cent of the annual average. Much of this decline is due to the provisions of the Securities Act of 1933, particularly the clauses providing criminal penalties for omitting "material facts" in circulars of information for new securities. These penalties would accrue to "essential expert advisers," as well as to corporation officials in the investment banking firms. The proposed new group of examining engineers would undoubtedly be classified as "essential expert advisors," but there is little reason to suppose that they would hesitate to sign statements purporting to give all the material facts in connection with water-supply projects to be financed from revenue.

Sound rate structures needed

While proper legislation and sound financial set-ups are needed for water-supply projects to be financed from revenue, it is equally important to provide equitable rate schedules. Upon such rate schedules depends, to a considerable extent, the certainty of collections for water sold and also satisfactory relations with customers. The PWA seems to have been more concerned with the sufficiency of the rate schedules offered than with their propriety from the basis of scientific ratemaking. For the long pull, both factors should be considered. Equitable rate schedules for water-supply projects should follow the same general principles that have been used for light and power.

Two-Rate Schedule Essential—It is now generally accepted that the most

equitable basis for assessing charges against electric consumers is on a two-rate schedule. One rate, usually termed a demand charge, is expected to provide sufficient revenues to cover all costs incident to the provision of adequate service facilities for the customer at any time that he elects to use the service, while the other rate, usually termed a consumption charge, should provide sufficient revenue to cover all expense required to produce and deliver the service by means of the facilities installed and financed out of demand charges. Practically all electric rate schedules are based on the above theory. Charges under other names such as minimum charges, flat rates, readiness-to-serve charges, energy charges, stepped rates based on room count, connected load or other factors are but variations of the two-rate schedule.

Water-rate schedules on the other hand, while they appear to attempt an equitable division of charges among the various classes of customers, do not seem generally to be predicated upon any accurate theory of rate-making. This inequity may be because the great majority of water systems are owned and operated by municipalities where rate research has been given inadequate consideration and where no organized group has forced regulation of the utility.

Minimum rates too low

Most water-rate schedules contain a minimum monthly or quarterly charge that is supposed to represent the cost to the city or water company of being ready to serve the consumer. Occasionally these minimum charges are graded on the basis of meter size. When tested by the theory of the two-rate schedule mentioned above, many of the municipal water-bill schedules do not provide a high enough minimum rate for the small domestic consumers. Many small consumers use a very small amount of water. If the minimum charge is not high enough, these customers do not pay as much for their water as it actually costs to supply them. Actual experience in raising such minimum rates for some PWA projects has resulted in very little dissatisfaction among customers. Where the water mains are included in the set-up, a minimum charge of less than $1 per month for domestic customers is usually insufficient. In some cases this minimum charge should be much higher. Where the water mains have been paid for by special assessment, only the waterworks costs are involved in establishing rates for demand and consumption, although occasionally in such cases it has been decided to include the water-main costs in the rate-making and to refund special assessment payments to the property owners, so that the entire water system will be truly self-sustaining. This has been done in Oak Park, Ill., where a part of the water mains were originally paid for by special assessments and the remainder purchased through the issuance of water certificates payable out of water revenue.

The value of a self-sustaining water system as a liquid asset was illustrated in Chicago some months ago when the city was offered $400,000,000 for its water system by a firm of investment bankers. This was in the time of deep financial distress. The price offered would have been enough to pay Chicago's school teachers and to clear up many other debts. The offer was not accepted, but the fact that it was made illustrates the value of including both waterworks and water mains in a water-revenue set-up with a real going value.

Fixed Charges—The total of the individual demand charges against customers in a water-rate schedule theoretically should equal the total of the fixed charges against the system. Naturally many different methods of establishing the total of fixed charges for rate-making can be employed. In ordinary rate suits, in the case of privately owned water systems, the fixed charges usually include an annual depreciation allowance for replacements and renewals, obsolescence, inadequacy, wear and tear and losses due to accidents and the like, plus a fair return on the appraised value of the property or "rate base." PWA procedure for municipally owned systems seems to favor making this item of fixed charges the summation of interest and amortization payments in each year, plus only so much for depreciation as will in all probability be needed for obsolescence, additions, improvements and minor repairs during the life of the bonds. This enforced liquidation of capital account through annual amortization payments is typical of all PWA financing with water-revenue bonds.

In all fairness the fixed charges should not be allowed to fall below the total of fair depreciation plus a fair return on the appraised value of the property. With municipal water systems free of debt, such fair return can logically be used for improvements or to reduce general property taxes. Many municipal water systems now only raise enough revenue for operating expenses and take no account of fixed charges in their rate structures.

Hydrant charges

In determining a schedule of demand charges an estimate must be made of the percentage of construction cost that is being used to provide fire protection and other public uses, and a direct charge in the form of hydrant rental or some similar charge should be made to care for this feature of the water-supply system. Even where the system is municipally owned, the hydrant rentals should be paid out of general tax revenues in a sound rate schedule. Ordinarily, from 20 to 60 per cent of the cost of a water-supply system for municipalities will represent provisions for fighting fires and other public uses, although 10 to 80 per cent variations do exist. The percentage varies with the size of the city, with the standards of design for both waterworks and distribution system, and with the density of population and character of building development. The accurate determination of a proper percentage is not easy.

Tax for Other Than Public Use—Indiana recently decided to tax water-supply systems for that part of their valuation devoted to other than public uses, which uses are fire protection, flushing streets, parks, schools and city buildings. This requirement necessitates arranging the rate schedules so as to add the item of taxes to the consumption charges. It also makes necessary a determination of the percentage factor referred to above for tax-assessment purposes. The State Tax Commission of Indiana has been making use of the following formula for the part of a municipally owned waterworks used for fire protection. The specific figure of 30.5 per cent used in the formula is for cities of 55,000 population, and varies with the population. "Deficiency points" refers to the rating method employed by the National Board of Fire Underwriters.

$$\text{30.5 per cent} = \text{per cent of plant used for municipal fire protection} = \frac{\text{1700—deficiency points on water supply}}{\text{1700}} \times$$

The percent of the plant used for municipal purposes other than fire protection is based on the ratio of such consumption to the total consumption.

Another solution of the problem involved in determining the percentage of construction cost involved in providing fire protection can be obtained by first producing an ideal design for fire protection and other public uses, the cost of which will be designated as A, and then for an ideal system to provide only private, i.e., domestic and industrial service, the cost of which will be termed B. In addition to these should be considered the cost of the actual system for which rates are to be established, the cost of which will be referred to as C. Then the percentage will be arrived at as follows:

$$\text{Valuation for public use only} = \frac{A}{A+B} \times C$$

Still another method ascribes to public use that part of the valuation that remains after deducting from the total of the appraisal the appraised value of that part of the system needed to provide adequate private service. This method at first glance seems fair and simple, but in practice with an actual water-supply system that is not ideally designed, as is usually the case, fire-protection demands in the case of actual

fires do tend to impair private service and do not employ the capacity over and above what is needed for private service.

Another method suggests that the figure for fire-protection valuation should be derived from the ratio of maximum fire demand to total combined demands for all uses.

If any of these various methods are used to determine the demand-rate portions of fair hydrant-rental charges, it will probably be an improvement over the existing rate schedule. Most municipally owned waterworks have no hydrant-rental charge. Where one is made, it is too often an outgrowth or copy of a charge made by some apparently similar system. A recent study of hydrant-rental charges made by privately owned water companies in small Midwestern cities showed variations in such charges from $31 to $66 per hydrant.

Care for Long-Range Planning—To avoid frequent revisions in the rate schedules, the item for depreciation reserves should take into account long-range planning of needed additions and improvements, so that the rates when established will be sufficient to care for a comprehensive construction program, tempered now perhaps by recent thought on population trends of municipalities. The advantages of combining such planning with the rate studies are evident, most important of which is the saving that will result from providing facilities only a short time before they are actually needed. Such combined studies will determine in advance what additions and improvements will be installed out of depreciation reserves, and what ones out of new issues of water-revenue bonds, so timed as not to disturb the rate schedules. These studies incidentally will also permit the setting up of modern books of accounting and will also result in a proper appraisal of the property or determination of "rate base."

Equitable Allocations Not Always Possible—In allocating the total of the demand charges to the various classes of customers, an attempt must be made to distribute such charges fairly among domestic users, commercial establishments and industries, as well as to assign to the municipality a proper charge for fire protection. In the case of industries, care must be taken that the rates are not so high as to encourage them to provide their own individual water supplies, although occasionally it may be sensible to permit that to happen rather than to furnish water to industries at less than actual cost. Ordinarily it will not be feasible to obtain all of the demand charges needed from levies for fire hydrants plus simple minimum charges to other customers.

This is true because ordinarily the fixed charges are relatively high, so that if the demand charges are strictly limited to minimum charges or flat rates, considerable opposition to the rate schedule will arise. It is difficult to convince most domestic customers that their share of the installation costs, including their proportion of the cost of service mains and feeders, is much higher than the operating or variable costs. For this reason use must then be made of some of the rate-making devices so skillfully employed by light and power companies or variations of such devices adapted to water-supply practice. These may include faucet count, connected population count, connected room count and stepped rates whereby various unit charges are made dependent upon the quantity of water consumed over a certain period of time. This is not strictly fair but meets with less opposition from consumers than if all revenue to carry fixed costs were derived from minimum rates. With industries, concessions can be made for the plants to draw water at off-peak hours or at lower pressures than other customers, and there are cases where large quantities of water can be delivered without the necessity of long and large supply lines. In most cases industrial consumption will not be a factor when the domestic demand is high for lawn-sprinkling and household usage. The addition of such industrial use to the system will increase the system load factor, and frequently can be handled with no increase in labor costs. Such factors should be considered in fixing demand charges. These added loads would cheapen the cost of service to domestic consumers; but to institute a favorable rate for such industries without undue complaint, the small consumers must be brought to realize the advantage in rates they are obtaining by the apparent favoritism to the large consumers, inasmuch as the industries might develop their own water supplies if the favorable rates for them were not set.

Consumption charges

In determining a schedule of consumption charges all costs of assembling and delivering water, including an allowance for taxes, costs of getting new and increased water sales and the costs involved in proper accounting and engineering studies for rate-making, checking of water revenues and improvements, should be included in the total of the consumption charges. These totals should then be fairly apportioned among the various classes of customers. Many of the principles described for allocating demand charges will apply to distributing consumption charges. Furthermore, due allowance must be made for the additional expense in reading meters and in billing and collecting involved in small domestic accounts as compared to large industrial users. Industries that take water at peak hours, necessitating additional labor costs and higher power costs because of poorer load factor, should pay higher consumption costs than plants that take water at off-peak hours. Experience in each water-supply enterprise will suggest other factors that should be taken into account in fixing consumption charges. In the case of hydrant rentals, the consumption charges will necessarily be comparatively low unless the city has a very bad fire-loss record.

For customers located outside city limits, rates will logically be set up so that they will receive equitable rates as compared to urban customers.

From a theoretical standpoint, it would appear that the preparation of a particular rate schedule for a water-supply system according to rational rate-making principles might present considerable difficulty in working out details. This does not happen to be the case. Once proper engineering studies have been made and the general principles of the two-rate schedule are fixed in mind with the task of formulating the rate schedule started, a rational set-up can be worked out easily. As the work proceeds, different variations in the schedules will suggest themselves, and eventually the rate-maker will have a schedule worked out that fits in quite well with the general principles advocated in this article. No perfect schedule from the viewpoint of theoretically correct rate-making is possible, but in most cases considerable improvement can be effected over the hit-and-miss schedules now in effect. Naturally the new schedules must be based on careful engineering studies, including water-waste surveys and cost-accounting, to determine the relative costs of providing water-supply facilities for each class of customers and for producing and delivering water to them. Only with such information can an equitable rate structure be built up. Too often existing water-rate schedules were copies from other water systems. As the process of copying went on, the chances of error in making fair charges increased each time a new schedule was adopted, until a rate schedule that originally may have been a fair arrangement in the hands of other municipalities soon became a makeshift affair.

In establishing any water-rate schedule by the rational method, a proper allocation of fixed and variable costs and income must be made so that, regardless of the use made of the system, enough revenue must be obtained to meet the total costs. As a matter of fact, good management and good rate-making should produce a surplus each year, over and above sinking-fund requirements. Where revenue bonds are to be issued or are outstanding, the rates should be set so that there is a satisfactory coverage of income over outgo. Even where the safety of investments in water department securities is not involved, it is desirable to produce surpluses to cover unforeseen expenditures and to permit reductions in rates during periods of depression.

ENGINEERING NEWS-RECORD

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A New Professional Society

A NEW professional society in engineering, the National Society of Professional Engineers, was organized on May 25, and on May 26 received the endorsement of the New York State Society of Professional Engineers at its annual meeting. Its purpose is improvement of the professional status of the engineer by the spread of licensing through all the states of the Union and by the development of strong professional societies in each state. Emphasis is to be on the local rather than the national unit. In the minds of the organizers is the idea that the new society ultimately will replace the American Association of Engineers, taking over its still active chapters as state or local chapters of the new society. Such a society has possibilities for service quite similar to that rendered by the A.A.E. in its early days of youthful enthusiasm. The latter organization set out to improve, and did improve, the professional and economic status of the engineer. Many of the laws affecting the practice of engineering and many improvements in the grading of engineers in civil service are the results of its efforts. Now there is need for greater uniformity in those laws, especially in the licensing laws, and a need for nation-wide acceptance of the latter laws. There also is need for enforcement such as can be obtained only through the watchfulness of an active local professional organization corresponding to the local bar association of the lawyers. In addition, there is growing need for an organization that will maintain an interest in the welfare of the subprofessional group. The A.A.E. could have done all these things had its original virility been maintained. But for some unknown reason that virility is gone except in a few localities. Such being the case, this new effort to coordinate state activities relative to professional development warrants support.

Congress and Public Works

How IMPORTANT the new public works bill introduced in Congress last week may prove to be depends both on the White House and on the convictions of the members of Congress. As yet there has come no definite evidence that the latter are prepared to heed the call of unemployment if to do so means a conflict with the President; for, this being a year of elections, the political argument is powerful. But the Congressmen know from their home contacts that re-employment has made too little progress to remove the need for continuing the job-making campaign. The meaning of the large present unemployment figure was interpreted in striking terms last week by a committee of the social workers' conference, which reported its belief that the CWA service is bound to continue for years, to provide work for those whom industry will not require. If, as Dr. Tugwell suggested at the same conference, "the essence of the New Deal" is to provide constructive work for those who under the old order were forced to depend on what is "a handout on the giving end and an insufficient dole on the receiving end," passage of the public-works bill is indispensable to make the New Deal beneficial to all. Needed work a-plenty is waiting to be done.

Construction Deficits

SPECIFIC EVIDENCE of fact such as recently developed in Detroit on street expenditures gives background to estimates that have been made of the huge accumulating deficit in construction, a shortage that constitutes a bill which later years and generations will have to pay. Reduction of street repair and maintenance in that city has created a deficit now approaching 10 per cent of the total investment and current expenditures have been cut to a figure so small that it could be justified only by a useful life of a century or more! The cost of maintenance, repair and replacement of streets, buildings, water pipes and other municipal facilities has been a favorite target of those groups which are intent on reducing municipal spending; but the obvious consequence is that costs are being piled on the future at an alarming rate. It is not realized by all that physical structures have definitely limited life, that merely to conserve existing facilities requires a definite expenditure each year, and that the work done year by year must bear a reasonable relation to actual depreciation lest wholesale and costly replacement in the near future become inevitable. While construction deficits are being accumulated, moreover, unemployment is increased by the idleness of men who otherwise would have been engaged in the work, and the cost of relief for these unemployed comes in the last analysis out of the same pockets that would have paid them for useful work. Thus the work now left undone must ultimately be paid for twice over.

The TVA Experiment

ACCOMPLISHMENTS of the Tennessee Valley Authority during the first ten months of its existence and its present objectives are briefly summarized in a letter to the President made public recently by Arthur E. Morgan, chairman of the Authority. The letter reflects the conservatism that has dominated the actions of the three members of the Authority in directing operations that could have been made anything but conservative under the very broad powers given to them. This is especially true with respect to building up a market for power. The TVA did not set an uneconomically low power rate, as it might have done in order to enter into destructive competition with the privately owned utilities of the region; instead it set rates that it thinks it can justify on a sound accounting basis, and already it has agreed with one of the large electric utilities of the region as to the area outside of which it will not actively compete for business. Further, the Authority is cooperating with the existing electric utilities in building up new power demands in order that there may be a market for the current developed by both the private companies and the TVA. Whether a sufficient demand can be built up without bringing in some large industries is an open question not touched upon by chairman Morgan in his report. He is an advocate of decentralization of industry, which implies small units, while David E. Lilienthal, the director having power questions as his chief concern, is believed to favor bringing in industries with a large demand for power as an essential to building up the

load that will make the TVA's power cheap. This question, however, can be left for later decision, as it will be many months before new power will be available.

Pay of Engineers

RULINGS on labor-rate provisions in industry codes have long been notorious as one of the strange instances of arbitrariness and inconsistency in the practices of the National Recovery Administration. Early codes fixed wage rates for various classes of workers, but later codes were restricted to a single wage-rate minimum, intended to apply to unskilled labor alone. When a code proposed to include other rates than the common-labor minimum, the NRA officials rejected the proposal on the ground that only one rate could be specified. For this reason among others, the successive drafts of the engineers' chapter of the Construction Industry Code, the latest of which still waits approval as we write, have for six months past included no pay minimum for engineer employees distinct from the 40c. common-labor rate. With approval two weeks ago of the plumbers' chapter of the code, which contains skilled-labor minima (equal to the PWA skilled rates of $1, $1.10 and $1.20 for the southern, middle and northern zones), the construction code now has two chapters that break the general rule. It may therefore be possible to obtain a reconsideration of the matter of writing minimum rates of pay for engineering employees into the engineers' code. It should be worth trying, for wage-chiseling is said to be not unknown in engineering practice; until it is ended, practice cannot be sound.

A Bill for Industrial Peace

TO WHAT DEGREE the Wagner industrial adjustment bill now pending in Congress will affect construction cannot be read directly out of the terms of the bill but remains to be learned from the action of the adjustment board which it proposes to establish. Though in detail adapted chiefly to factory conditions, the bill is of concern here because its application extends to construction and because it is of extraordinary importance as an effort to improve labor relations.

In intent the bill is designed to bring industrial peace—to correct such conditions as lie back of the bloody strikes that are current front-page news. In other words, it is directed toward outlawing oppressive acts by either employers or labor, eliminating feudalism from industry, and making impossible labor-organizer racketeering and padrone exploitation of the worker by his own representatives. Accomplishment of these purposes requires that a way be provided to establish fair and equitable working conditions not only through collective bargaining as recognized by the Recovery Act but also through other means applicable when collective-bargaining agreements cannot be reached.

The provisions of the bill are summarized in the news pages of this issue. Briefly, it sets up certain new restraints upon employers but none upon labor. It does not, however, compel the settlement of industrial disputes or provide for deciding controversies over wages and hours. Beyond setting up an official arbitration tribunal which may act when both parties request it to do so, and beyond a strange and unclear provision for determining worker representation, it makes no contribution to industrial peace.

That the bill sets up an arbitration mechanism is of interest to the construction industry, whose code has already provided an arbitration tribunal—the National Planning and Adjustment Board. Whether the new mechanism nullifies the authority of the latter is an interesting question, since Sec. 15 of the bill states that in any conflict with application through a code of the famous Sec. 7(a) of the National Industrial Recovery Act the provisions of the bill shall prevail. But in view of the far larger issues involved this point is at present secondary.

Taking the bill as a whole, it is negative; whatever positive elements it contains are one-sided. For this reason it gives no promise of bringing industrial peace and harmony; it is more likely to be an incitement to discord.

Far from ending or discouraging strikes, the bill encourages them. Its Sec. 14 gives explicit recognition to the strike in these words:

> Nothing in this act shall be construed to require any employee to render labor or service without his consent, or to authorize the issuance of any order or injunction requiring such service, or to make illegal the failure or refusal of any employee individually, *or any number of employees collectively*, to render labor or service.

An obvious surplusage that in no way alters existing rights, this section clearly has the effect of giving support and sanction of law to the strike as the approved means of settling industrial disputes. The bill provides no other means of settlement.

As a contrast to this clause we cite some forceful and enlightening remarks made some days ago by Col. Henry M. Waite, Deputy Administrator of the Public Works Administration, at the dedication ceremonies of the Midtown Tunnel, New York. In asking for cooperation between governments, contractors and labor Col. Waite said: "Labor must realize that it has a vast, unselfish duty to perform. The public is struggling in every way possible to get people back to work. The public mind cannot understand, nor will it tolerate, strikes. When people are demanding work, with vast throngs on relief rolls, the public mind cannot comprehend why those having work strike." These sentiments, we believe, will have the hearty endorsement of the great majority of citizens.

With its many shortcomings and defects, the bill is powerless to bring progress toward industrial peace. If it is to accomplish its high purpose, and if this purpose is best attained through recognition of organized labor, two positive steps appear indispensable: First, provision for direct settlement of industrial disputes by compulsory arbitration; and second, governmental supervision of labor organizations. Industrial peace and abolition of destructive strikes require the first; effective enforcement and fairness to both worker and public require the second. In the interests of the worker, of industry and of the public alike, the bill should be amended and implemented by inclusion of such provisions.

CURRENT NEWS

Bill to Govern Labor Disputes Reported to Senate

THE SO-CALLED Wagner labor disputes bill, the purposes of which are "to equalize the bargaining powers of employers and employees, to promote the amicable settlement of labor disputes, to create a national industrial adjustment board, and for other purposes," was reported to the Senate on May 26.

The bill defines four unfair labor practices:

1. For an employer to attempt to impair the exercise by employees of the right to form or join labor organizations, to designate representatives of their own choosing, and to engage in concerted activities for the purpose of collective bargaining or other mutual aid or protection.

2. For employees to attempt to impair the exercise by employers of the right to join or form employer organizations.

3. For an employer to interfere with or dominate the administration of any labor organization or contribute financial support to it.

4. For an employer, by discrimination in regard to hire or tenure of employment or any term or condition of employment, or by contract or agreement, to encourage or discourage membership in any labor organization. The provision is made, however, that an employer shall not be precluded from making an agreement with a labor organization to the effect that a person seeking employment shall be required to join such labor organizations, if the agreement is sought by a majority of employees in the unit covered by it, when made.

Industrial adjustment board

The bill creates a national industrial adjustment board to consist of five members. Three are to represent the general public and are to be appointed by the president. One of the three is to be designated chairman of the board. They shall not engage in any other employment while serving on the adjustment board.

The other two members of the board are to be selected from two panels of six individuals each, appointed by the president, one panel representing employers and the other representing employees. The selection of board members from these two panels is to be made by the chairman of the board.

The board is empowered to prevent any person from engaging in any of the unfair labor practices, by issuing an order, after having conducted a hearing on the matter, requiring such persons to cease and desist from the practice complained of, or to take affirmative action that will achieve justice under the circumstances. If the person receiving such an order should fail to comply with it, the board is empowered to petition a Circuit Court of Appeals for the enforcement of the order.

(Continued on p. 722)

Water Supply Improvements Recommended for Dallas, Tex.

Expenditures totalling $2,852,840 to meet the needs of the city's water supply during the next twenty-five years have been recommended for Dallas, Texas, by the Pitometer Co. following a survey of the water system.

Immediate construction was urged of a new 36-in. conduit costing $600,000 from the Bachman pumping station across the Trinity river to the Sunset reservoir and pumping station in Oak Cliff. The report also recommended the abandonment of Oak Cliff's artesian water supply as soon as mains can be built to carry surface water to that community. (*ENR*, May 24, 1934, p. 679.)

The report predicts that the population of Dallas will reach 350,000 by 1940, 400,000 by 1950, and 450,000 by 1960. The total daily water consumption is expected to increase from 22.9 m.g.d. to 25 m.g.d. in 1935, 32 m.g.d. in 1940, and 45 m.g.d. in 1960.

The report recommends the construction of $300,000 worth of mains within five years, exclusive of the projects listed for immediate construction.

Government Takes Title For First Housing Job

The Federal Government now holds [illegible] title to the site for the first housing operation to be undertaken by the Public Works Emergency Housing Corporation, Administrator Ickes has announced. The Administrator also announced that options are held on 65 to 70 per cent of the properties comprising a second site and that condemnation proceedings have been instituted with a view to acquiring the entire tract at an early date.

The project on which a title to the site has been obtained by the government is known as the University Project, in Atlanta, Ga. The government has received court notice that it may occupy the site on June 15. Meanwhile it is proposed to contract for the demolition of the existing slum buildings, mostly frame bungalows and shacks in a deteriorated condition.

The project on which the options are held is known as the Techwood project, also in Atlanta. Condemnation proceedings against this site will be heard on July 2. The project will afford living accommodations at Georgia Technological Institute.

National Professional Society Launched To Coordinate State Engineering Societies

A NEW professional society within the engineering profession, was provisionally organized at New York on May 25, as the National Society of Professional Engineers. On the following day the New York State Society of Professional Engineers, at its annual meeting in New York, by unanimous vote, gave its approval to the formation of such a society to coordinate the activities of the state societies of professional engineers. Professional engineering societies from five states, New York, New Jersey, Pennsylvania, South Carolina and Oregon, were represented at the meeting, also the American Association of Engineers. D. B. Steinman, past president of the New York State Society of Professional Engineers and of the American Association of Engineers was elected temporary chairman, and Gerald W. Knight of the New Jersey Association of Engineers was elected temporary secretary. Committee chairmen were named as follows: Arthur V. Sheridan, executive committee; John C. Riedel, constitution committee; T. Keith Legaré, membership committee; and Hugh A. Kelly, publications committee. It is expected that the organization details will be sufficiently worked out to call the first regular meeting of the society in January of next year. A tentative location of the headquarters of the society has been placed at Washington, D. C.

The society will have as its major objective the improvement of the professional status of the engineer through the promotion of license laws in states now not having such laws, and through the fostering of state societies to promote the local advancement of the engineering profession. Existing state societies of professional engineers would become state chapters of the national society, under the proposed set-up, and it is the hope of the organizers that local chapters of the American Association of Engineers also will become the chapters of the new organization and that, ultimately, the new organization will supplant that association. By thus bringing all state societies interested in professional matters under one head, it is hoped to be able to bring about greater uniformity in legislation effecting the practice of engineering and to facilitate the passage of license laws in states not now having such laws.

Emphasis is to be placed on the development of strong local units, rather than a strong national unit, on the grounds that the great majority of questions affecting professional engineers are matters of local legislation. Membership is to be restricted to licensed engineers in states having licensing or registration laws, and where state or county chapters of the local societies are in existance membership will depend on membership in the local organization. The present aim is to set the dues at $10 annually, $3 to go toward the expense of the national organization, $1 toward the publication of the national society, and $6 towards the dues of the local unit. It is proposed to consolidate local society publications with the present publication of the American Association of Engineers.

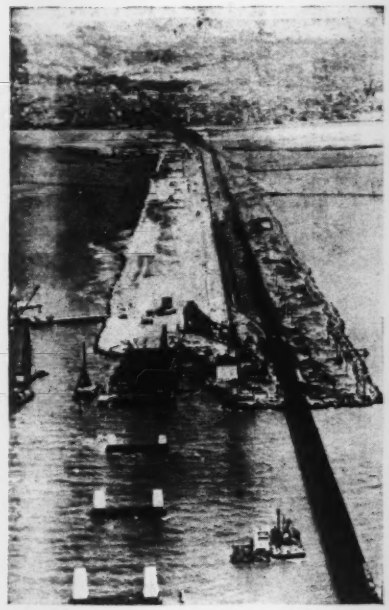
Sewer District Proposed For St. Louis Suburbs

A petition for the incorporation of a new sewer district in St. Louis County, Missouri, to cover about 135 square miles in the most heavily populated section has been filed with the Circuit Court. The estimated cost of the project is $5,700,000. The population in the affected district is about 150,000. If the court approves the plans it is proposed to hold a bond issue election next fall to finance the project. The district would be known as the Sanitary Sewer District of St. Louis County.

Municipal Bankruptcy Bill Signed by President Roosevelt

A bill authorizing insolvent cities and other local political units to seek readjustment of their debts was signed by President Roosevelt on May 25.

The bill as signed by the President is limited to two years. During that time it permits bankrupt local governments to file a petition in court accompanied by a plan of settlement, provided consent is obtained from 51 per cent in amount of their security holders. If the settlement meets with the court's approval, the court may order it executed, but only after receiving consent in writing of creditors holding two-thirds in amount of each class of claims affected by the plan and also of those holding three-fourths in amount of all securities.



OAKLAND APPROACH, SAN FRANCISCO BAY BRIDGE

Filling operations along the north side of the Key Route Mole are progressing rapidly, in providing the east approach to the San Francisco-Oakland Bridge. Also the last pier for the 292-ft. deck truss spans is nearing completion. The toll houses will be located on the fill about where the bend in the rail line occurs.

Old Water Tank on Roof Falls Through Five Floors, Killing Three

A 40,000-GAL. wooden tank on top of the 7-story Oakley Building at the northwest corner of Austin and La Salle Sts., Chicago, rotated on one of its supports on May 22 and crashed through the roof and five floors, coming to rest above the second floor. Three persons were killed and a half dozen injured in the rush of water and debris that followed the collapse. The tank was installed in 1892 and no plans of the building or tank installation exist at the building department. The erector had even forgotten that he had installed them. Dimensions and capacity figures therefore are only estimates from observation of the ruins, which are being demolished slowly under close orders of the coroner, fire and building departments of the city. The building was occupied by several laboratories, printing shops and wholesale companies.

According to the early views of the engineers of the building department, before all the evidence was available, the accident may have occurred from a shifting of the tank position in the high winds a few days prior to the collapse when the tank was nearly empty. The tank collapsed about 15 min. after refilling.

The tank was supported on a tower 10 or 12 ft. high carried on supports placed diagonally across the corner between the north outside wall and a north and south dividing wall, both of brick. The shorter support was a beam 18 ft. long made up of two channels back to back, the longer support a truss 14 ft. deep and about 40 ft. long. The beam shows evidence of being lifted, while the appearance of the truss indicates that the tank rotated about its upper chord.

The wooden tank was about 20 ft. in diameter and 15 ft. high. It and the immediate supports under it were all the wood involved so that reports that dry rot in the wood columns and beams of the building itself contributed to the accident are inaccurate.

A steel pressure tank of 1,000 gal. capacity, located above the roof under the wooden tank, was supported by the truss. It and the truss remained suspended at the sixth floor level. Both were considered dangerous and were cut away by acetylene torches before the debris of floors and beams below it were removed in the search for the bodies of missing persons.

The front of the building was cut off some five years ago when La Salle St. was widened, and a new brick front added. While the building generally was of mill-type construction of wood columns and floor beams supported on saddles over timber girders, it had I-beam columns in the two upper floors and concrete columns in the two lower floors. The floors were of 2-in. plank topped with two layers of parallel flooring. Inspection showed little evidence that this 42-year-old hodgepodge construction had much if anything to do with the accident, though it may have accentuated the extent of the collapse, which extended over four or more square bays at the top floor, narrowing to two or three at the third floor.

N.Y. State Society Opposes a Code For Engineers

THE New York State Society of Professional Engineers, at its annual meeting held in New York on May 26, after a long discussion of the proposed code for the Engineers Division of the Construction Industry, went on record as opposing all attempts to put the profession of engineering under an industrial code. This action was taken following the presentation of the report of the society's code committee in which the committee recommended that the society neither support nor oppose the present draft of the engineers' code. The committee was of the opinion that the present code is unsatisfactory, but that in order to have a voice in further code developments it was opposed to any action by the society that would eliminate it from code discussions.

Code applies only to a few consultants

In the committee's report and in discussions it was brought out that because of the limitations of the Recovery Act itself, and because of further limitations set up by rulings of the NRA, the number of professional engineers to whom the present code applies has been reduced to a very small number of practicing consultants who still employ a staff of assistants, that the individual consulting engineer who has his office "in his hat" is unaffected, and that the vast amount of engineering work done by public bodies and by corporations incidental to industrial operations is entirely outside of the scope of the engineers' code.

The code committee reported that it had followed the code development work carried out by the code committee of the American Society of Civil Engineers, that it had cooperated in the preparation of the earlier draft of the code, that subsequently it had submitted the many suggestions as to the changes needed in the drafts under consideration, but that the suggestions consistently had not been acted upon, and that more recently, when the committee had endeavored to participate in discussions of the code, it had been informed that the only way it could take part was through the presentation of written comment for the consideration of the Am. Soc. C. E. code committee. The state society's committee reported further that because it was a local organization it had no standing before the NRA in Washington.

In view of the fact that only a limited number of engineers were affected by the code, that the NRA had ruled that professional men did not come under the provisions of the Industrial Recovery Act, and that the present code as drafted was quite unsatisfactory, the society, by resolution, went on record as opposing further attempts to put engineers under a code.

New society endorsed

Formation of the National Society of Professional Engineers to integrate the activities of the state societies of professional engineers, was endorsed by the society, as noted elsewhere in these pages. Following an outline of the objectives of the new society by D. B. Steinman, a resolution endorsing the proposal to form such a society provided that certain limita-

tions as to proportional representation be included in its constitution, was brought up but was rejected on the grounds that it was undesirable to check up such limitations, and a substitute resolution giving endorsement to the proposal was adopted.

A resolution was adopted by the society urging the National Council of State Boards of Engineering Examiners not to issue a certificate of its National Bureau of Engineering Registration to an engineer resident in a state having a license law unless the engineer is the holder of a license in that state.

Four new chapters were added to the society during the year, bringing the total number to 29. The membership now exceeds 2,600 of the 8,000 licensed engineers in the state.

During the year the society has been active in seeking out violations of the engineer license law, and has been instrumental in having the state take action in a number of cases, one resulting in conviction for fraud due to misrepresentation, and one resulting in the closing of a school professing to teach engineering.

Arnold G. Chapman, chief engineer, Albany Port District Commission, was reelected president; Frederic R. Harris and John C. Riedel were elected vice-presidents; Ernest F. Fox was reelected financial secretary, and Patrick M. Corry, treasurer.

Labor Disputes Bill Reported to Senate

(Continued from p. 720)

The board shall have power to act, and to appoint any agent or agents to act, as arbitrator in labor disputes, when parties agree to submit the whole or any part of the dispute to the arbitration of the board. The arbitration award is to be filed in the United States District Court, and the court shall enter final judgment confirming it, provided a petition to impeach the award has not been filed.

The United States Courts are vested with jurisdiction to entertain proceedings and to enforce all judgments in arbitration.

The board is authorized to take a secret ballot of employees, or to utilize any other suitable method to ascertain by whom or by what labor organization they desire to be represented, when the question of proper employee representation is in dispute.

The provisions of the act are limited in the following words:

"Nothing in this act shall be construed to require any employee to render labor or service without his consent, or to authorize the issuance of any order or injunction requiring such service, or to make illegal the failure or refusal of any employee individually, or any number of employees collectively, to render labor or service."

In case of conflict between this act and the provisions of any code, the following paragraph governs:

"Wherever the application, by means of code, agreement or otherwise, of the provisions of Section 7 (a) of the National Industrial Recovery Act conflicts with the application of the provisions of this act, the provisions of this act shall prevail; provided, that in any situation where the provisions of this act cannot be validly enforced, the provisions of Section 7 (a) of the National Industrial Recovery Act shall apply."

Three Subdivisions Proposed For Contractors' Code

A PUBLIC hearing was held and adjourned in Washingon, D. C., on May 21 on three supplemental codes which, if approved, will form subdivisions of the General Contractors Division (Chap. II) of the construction industry code. The three subdivisions of the approved general contractors code have been designated as: (a) Building Contracting Industry, (b) Heavy Construction and Railroad Contracting Industry, and (c) Highway Contracting Industry. The hearing was adjourned for three weeks on the call of the Administrator.

Building contracting

The proposed code defines a building contractor as a general contractor who, by contract or otherwise, erects or superintends or executes the work of constructing a building costing more than $1,000. The administration of this proposed subdivision will be through an administrative committee consisting of 14 members, 9 of whom shall be members of the Association (Associated General Contractors of America) and shall be appointed annually by the building contractor members of the divisional code authority provided for in Chapter II. The five additional members shall be approved by the Administrator and shall be persons who are engaged in the business of building contracting, who are not representative of or responsible to members of the Association. This committee shall appoint local committees in regions or localities when requested to do so by representative groups of building contractors in these areas. These local committees shall consist of not less than three or more than nine building contractors in the locality.

Heavy construction

Heavy construction and railroad contractors are defined as any agency undertaking to erect, superintend or execute the work of building any fixed structure or improvement or making additions or repairs thereto where custom recognizes such work and services as "heavy construction and railroad construction." The definition goes on to include a variety of engineering projects, which is extended and which concludes with the statement that it is intended to cover all general contracting which is not covered by the subdivisions for building contracting (IIa) and highway construction (IIb).

The administration of this subdivision will be carried out by an administrative committee composed of 14 members, 9 of whom shall be members of the Association (Associated General Contractors of America). These members shall be appointed annually by the heavy construction and railroad contractor members of the divisional code authority provided in chapter II. These nine persons shall annually appoint to the administrative committee five additional persons, to be approved by the Administrator, who are engaged in the business of heavy construction and railroad contracts, and who are not members of the Association.

This subdivision also provides for the establishing of regional or local committees to be in direct charge of the administration of the code.

Highway contracting

A highway contractor is defined in this subdivision as any agency doing work where custom recognizes such work and services as highway contracting or construction, excepting operations aggregating less than $300 and excluding heavy construction and building construction.

The administration of this subdivision shall be in the hands of a national administrative committee composed of 13 members, eight of whom shall be members of the Association (Associated General Contractors of America) appointed for a two-year term by the highway contractor members of the divisional code authority and these eight members shall appoint for the term of two years five additional persons engaged in the business of highway contracting who are not members of the Association. This committee shall appoint commitees for each of the states, known as State Committees, each to consist of not less than three or more than fifteen persons engaged in the business of highway contracting. These state committees are to have the powers and duties necessary to enforce provisions of the code relative to bidding and other administrative functions.

Seattle Prepares To Resume Work on Skagit Project

Overriding the Mayor's veto of a $5,000,000 bond sale ordinance, the Seattle, Wash., city council has paved the way for an early resumption of construction on the Skagit hydro-electric power project. The ordinance becomes effective June 16, and superintendent of lighting J. D. Ross will get the work under way immediately thereafter.

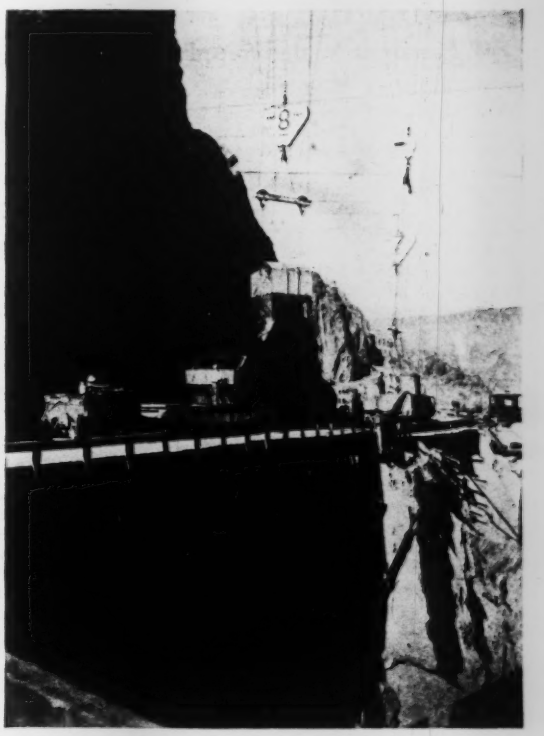
The first move will be to pay off the $1,800,000 of construction warrants outstanding on the Diablo plant. The city will then advertise for bids and let a contract for the completion of the Diablo power house. Other work planned is the construction of a transmission line from the Diablo plant to the Gorge and the completion to two full stories of the City Light Building.

Unfavorable Report Submitted on Canal to Bay of Fundy

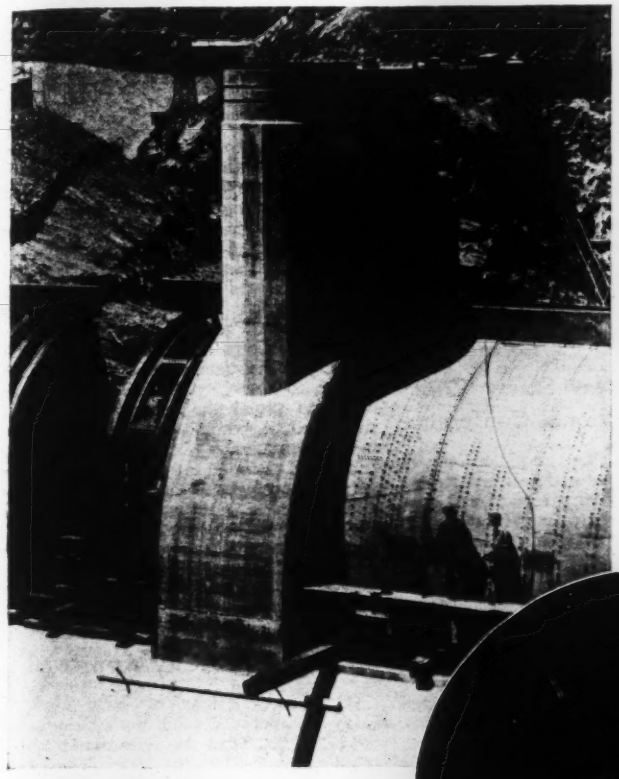
An unfavorable report on the proposed Chignecto Canal to facilitate the movement of shipping from Atlantic Coast ports to the Gulf of St. Lawrence was submitted to the Canadian House of Commons on May 22 by the royal commission appointed to make another inquiry into the project. The proposal calls for the construction of a ship canal across the narrow strip of land joining Nova Scotia with New Brunswick and separating the Bay of Fundy from the Northumberland Strait.

The Commission was composed of Arthur Surveyer, consulting engineer, Montreal; D. W. Robb, Amherst, N. S., and J. F. Sowards, Kingston, Ontario. In its report it found the project feasible, but pointed out that the high cost (estimated at about $23,000,000) caused by the tidal conditions to be overcome, made it uneconomical. Two opinions were expressed in the report as to the route to be taken.

CURRENT VIEWS OF BOULDER DAM ACTIVITY

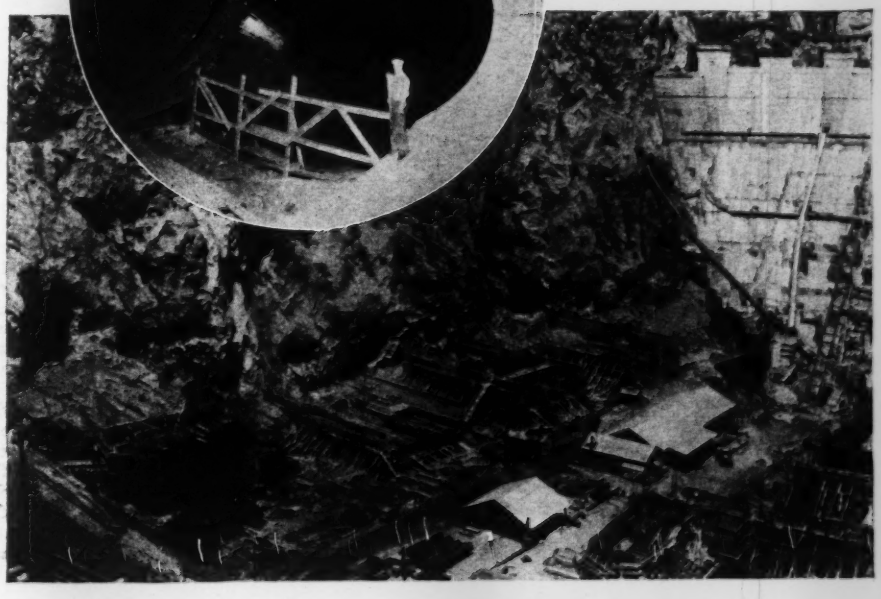


Special side-dump concrete buckets of 8-cu.yd. capacity are handled by cableway from trains operating along the Nevada canyon rim from the high-level mixing plant.



Steel work on one of the 100x16-ft. drum gates on the Arizona spillway crest.

In this 37-ft. header tunnel will be installed the 30-ft. steel penstock pipe with 13-ft. diameter branches turning off into the 18-ft. diameter tunnels (entrance shown) leading to the powerhouse.



Powerhouse foundation work on the Nevada side of the canyon showing the outlets of the eight penstock tunnels. The powerhouse extends for about 500 ft. from the downstream toe of the dam.

Morris Dam Dedicated For Pasadena Water Supply

The $7,500,000 Morris Dam, of the Pasadena, Calif., water supply system was dedicated by ex-President Hoover on May 26. The concrete structure impounds 39,300 acre-ft. of water and is part of the link in the chain of lakes and aqueducts that will join Southern California with the Colorado River. The dam cost $4,000,000 and an additional $3,500,000 was expended for water rights and other essentials. It was named after Samuel B. Morris, chief engineer of the Pasadena water department.

Power Review Board Set Up by PWA

The Public Works Administration has established an electric power board of review to review disapprovals and special conditions imposed by any division of the PWA and make recommendations with regard to application of public bodies to finance the construction, repair, improvement or extension of electrical power plant facilities. The board will be comprised of Henry T. Hunt, general counsel of the PWA, Morris L. Cooke, chairman of the Mississippi Valley Committee and Otto M. Rau, counselor for Administrator Ickes.

Administrator Ickes has directed the power board to formulate and submit instructions for the guidance of various divisions of the PWA with regard to controversial questions affecting this class of project, so that uniform policies and handling of these questions might be evolved.

Boulder Dam Builders Submit Low Bid for Highway Tunnel

A low bid of $3,683,931 was submitted by the Six Companies of California, Inc., composed of the contracting group now building Boulder Dam, for the construction of the low-level tunnel which will improve the highway approach facilities on the east side of Oakland, Calif.

The next two bids were: Frazier-Brace Construction Co. and G. L. Tarlton, St. Louis, $4,394,613.

Silas Mason Co., New York City, $4,482,498.

The Six Companies of California, Inc., is composed of W. A. Bechtel Co., Henry J. Kaiser Co., Utah Construction Co., MacDonald & Kahn, J. F. Shea, and Morrison-Knudsen Co., which is the same group comprising Six Companies, Inc., at present building Boulder Dam. Officers of the new company are S. E. Bechtel, president; Frank Modglin, vice-president; Edgar F. Kaiser, secretary, and L. S. Corey, treasurer.

District direction

The tunnel, which is 5,620 ft. long, is being built by California Joint Highway District No. 13, comprising Alameda County and Contra Costa County. It will consist of a twin highway bore through the foothills rising abruptly on the east side of Oakland. The project will provide a much needed highway approach improvement and eliminate a present tortuous grade on the main highway from the East Bay metropolitan area into the interior of the state.

The project has been under discussion and plans have been drawn for several years. The delay has been occasioned by arrangements providing for the taking over of the approach route by the state highway commission as part of the state system. Wallace B. Boggs is chief engineer of the project.

Warren J. Mead Appointed Head of M.I.T. Geology Department

Warren J. Mead, professor of geology at the University of Wisconsin since 1918 and a member of its staff since 1906, has been appointed head of the department of geology at the Massachusetts Institute of Technology. He will assume his duties at Cambridge in the fall, succeeding Waldemar Lundgren, who retired in 1933. During the interim Harvey W. Shimer has been acting head of the department. Dr. Mead is a native of Plymouth, Wis., and was graduated from the Wisconsin institution in 1906. He was awarded a master's degree in 1908 and the doctorate in 1926. For more than 25 years Dr. Mead has served as a consultant in mining, economic and engineering geology, including work for the Panama Canal Commission and the United States Corps of Engineers.

Uniform Highway Safety Codes Adopted by National Conference

Revised uniform laws and ordinances governing the safe use of roads and streets by vehicular traffic and a revised and consolidated manual of traffic safety devices were adopted at the assembly in Washington, D. C., last week of the National Conference on Street and Highway Safety. In six active sessions the nearly 400 delegates considered the six laws and the manual section by section and approved or amended each section by full conference vote. The amendments were numerous but, except for two, were directed to verbal clarification and minor corrections.

Active difference of opinion arose over the sections of Act V, Regulating Traffic on Highways, which set up special color combinations in signals and which set up maximum gross weights for vehicles. Technical discussion on these two sections will be developed in our next issue; it is noted here that the section on special color combinations was stricken from the act without substitution and that the tabulation of gross weights (*ENR*, May 17, 1934, p. 669) was deleted and a substitute section was adopted which placed control of gross weights under the state highway administrations.

An important reorganization of the uniform municipal ordinance was directed by resolution that the ordinance be divided into three separate parts, the first part to be known as the Uniform Municipal Traffic Ordinance and to contain those provisions which apply to and govern the actions of the users of the streets and highways; the second part to contain those provisions which are purely administrative and shall be recommended for adoption by municipalities in such parts or part as is permissible under their charters, or financial ability to perform; the third part to contain provisions contained in the state code which may be repeated in a local ordinance.

Contract For Three Buildings Let by Rockefeller Center

Rockefeller Center, New York, has announced that a contract for the construction of three new buildings has been awarded to John Lowry, Inc., of New York City. Construction will be started immediately.

The buildings will be situated between 50th and 51st Sts., in the north block of Rockefeller Center. They will comprise a group of two six-story structures and a 38-story tower connected with them on the west. The ground area occupied will be 57,000 sq.ft.

Housing Authority Planned for Columbus, Ohio

Permission to create a municipal housing authority has been granted the city of Columbus by the Ohio Board of Housing. Cincinnati and Cleveland already have such authorities which have the power to condemn land, borrow money, erect and operate large scale low-cost housing projects. Members of the housing authorities are appointed by the Mayor, Common Pleas Court, Probate Court and the Board of County Commissioners. Mayor Worley of Columbus relinquished his appointive power to the City Planning Commission and has urged the other agencies to do likewise. A committee of the City Planning Commission headed by Professor Edwin S. Burdell of Ohio State University has completed a survey of 59 city blocks located in eight areas, revealing the existence of serious slum conditions in Columbus. It is in these areas that the new authority hopes to work.

Loan to Speed West Side Work in New York City Approved

Governor Lehman of New York, on May 26, approved a bill authorizing a loan of $7,000,000 from the state grade crossing elimination fund to the New York Central R.R. Co. The money is to be used to defray part of the cost of the work included under the agreement between the city and the railroad company covering the work of eliminating the railroad company's tracks from the streets on the west side of Manhattan Island, New York. That agreement called for elevating the tracks from Canal St. north to the 30th St. yard, and depressing the track north from the 30th St. yard to the 60th St. yard in a private right of way between 10th and 11th avenues, also decking over the company's tracks north of the 60th St. yard to provide for an extension of the West Side Elevated Highway parallel to Riverside Drive. Work on the elevated structures south of the 30th St. yard is well along toward completion, but little work except acquisition of right-of-way and razing of buildings has been done between the 30th and 60th St. yards. At the present time the elevated highway has been completed over the railroad company's 60th St. yard, with a temporary connection to Riverside Drive at 72nd St. The work now to be undertaken will include decking over the tracks north of 72nd St., to provide for a new highway to relieve congestion on Riverside Drive.

SOCIETY CALENDAR

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting at Cornell University, Ithaca, N. Y.; conferences, June 19-21, regular meetings June 21-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, spring meeting, Jamestown, N. Y., June 15-16.

THE PENNSYLVANIA SOCIETY OF PROFESSIONAL ENGINEERS has been organized with T. W. Battin, president, and Sheldon A. Keast, executive secretary, 921 Widener Bldg., Philadelphia.

Obituary

BENJAMIN J. CURTIS, a civil engineer recently made commissioner of streets and electricity in Chicago (*ENR* Jan. 4, p. 26) died in Chicago on May 19 at the age of 43. Mr. Curtis was graduated from the University of Minnesota as a civil engineer. Except for an interval of five years he was with the Sanitary District of Chicago continuously from 1914 to 1932. When Edward J. Kelly, chief engineer of the district, was made mayor of Chicago he took Mr. Curtis with him for special investigations.

AUSTIN THOMAS BYRNE, who served as a sanitary engineer under Major General Leonard Wood during the occupation of Cuba following the Spanish-American War, died at Ardonia, N. Y., on May 24, age 75. Mr. Byrne was born in Belfast, Maine, and graduated from Trinity College, Dublin, as a civil engineer in 1876. Previous to the outbreak of the Spanish-American War he was in highway construction work.

CAPTAIN ROBERT A. BLAIR, Quartermaster Corps, U. S. Army, died at Fort Lewis, Wash., on May 20, age 54 years. Captain Blair was a graduate civil engineer from the Iowa State College, in the class of 1903. From 1903 to 1907 he was in the engineering department of the Bureau of Public Works at Manila, and in 1908 entered the construction division of the Quartermaster Corps of the Army.

HAROLD J. PIERCE of the Pierce Construction Company, Syracuse, N. Y., was drowned on May 21 in a boating accident near his summer camp on Skaneateles Lake, N. Y.

CONSTRUCTION STATISTICS OF THE WEEK

Private construction awards raise this week's total 42 per cent above last week in spite of the short week due to the Decoration Day holiday. Total awards for the week are $28,549,000 of which $11,210,000 is for private contracts and $17,339,000 for public works. Of the public work $2,935,000 represents federal awards and $14,404,000 state and municipal. The total for the first five months is 45 per cent ahead of last year in dollar value.

Commercial building awards are responsible for the week's high total. At $9,007,000 they score their highest week this year by double the amount of the previous high week. Highways are up at $7,406,000; bridges, at $1,644,000, are higher than last week, industrial buildings at $1,481,000 are 50 per cent over last week. Water works at $743,000 are slightly down, sewerage at $635,000 is considerably below previous weeks, and earthwork, irrigation and drainage is about 50 per cent below last week.

Large contracts include a store and office building at Rockefeller Center, New York City, $8,000,000; the planetarium at the American Museum of Natural History, New York City, $509,000; Camp buildings, Group 3, Fort Peck Dam, Montana, $742,000; highway lettings by Alabama, $636,000, by Texas, $628,000, by California, $528,000 and by Georgia, $653,000. Miscellaneous awards include the transformers for Boulder Dam, $1,000,000, and the gas holder for Metropolitan Utility District, Omaha, Neb., $640,000.

New financing was lower for the week and was distinguished by the entrance of the RFC as a major purchaser of municipal bonds. The PWA allotment to Los Angeles for school buildings was reduced and $1,145,000 for school buildings was loaned to that city by the RFC. Other bond purchases by the RFC include stadium bonds from Columbia, South Carolina, $24,000, and water works bonds from Deer Lodge, Montana, $180,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average May 1933	Prev. 4 Weeks	Week May 31 1934
Federal Government	$751	$3,196	$2,935
State and municipal	14,360	14,646	14,404
Total public	$15,111	$17,842	17,339
Total private	4,438	4,206	11,210
Week's total	$19,549	$22,048	$28,549
Cumulative to date: 1933	$359,390	1934	$520,981

NEW PRODUCTIVE CAPITAL

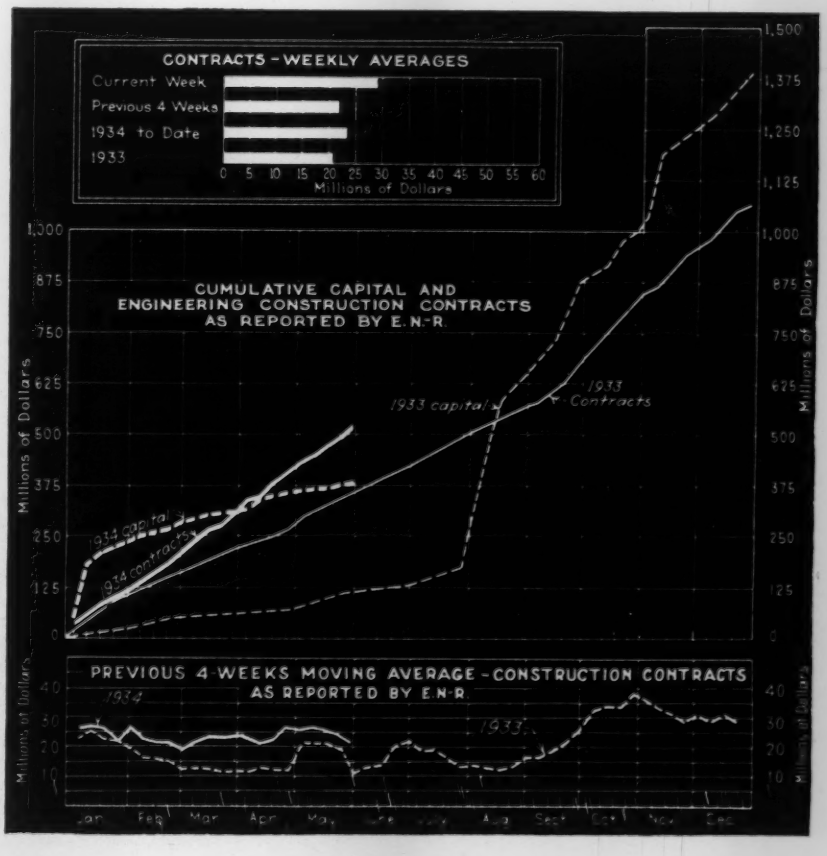
(Thousands of Dollars)

1934	Week May 31	Cumulative
State and municipal	$3,116	$129,077
PWA allotments, S&M	1,734	185,103
RFC loans, S&M	1,349	1,349
Corporate issue	553	13,542
PWA allotments, private	....	50,417
Total, Non-Federal	$3,294	$380,498
PWA allotments Federal Constr.	15	49,461
Total new capital	$3,309	$429,959
Cumulative to date: 1933	$125,425	1934 $380,498

NOTE: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

E.N.-R.-Cost		E.N.-R.-Volume	
May, 1934	199.61	April, 1934	109
April, 1934	195.86	March, 1934	108
May, 1933	164.39	April, 1933	65
1933 (Average)	170.18	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100		

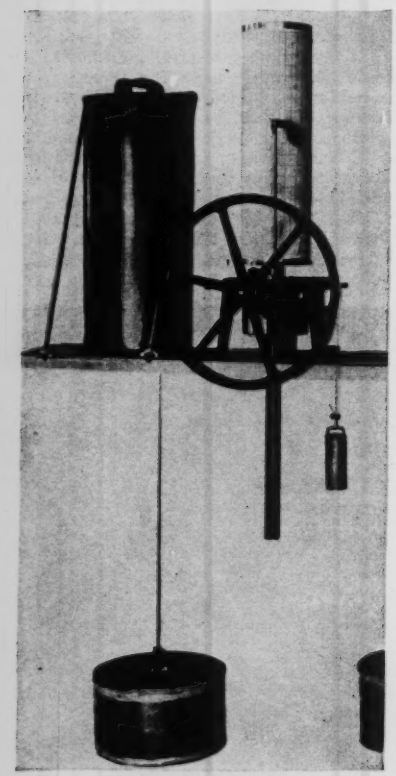

CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1934 to Date
1933
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1933 capital
1933 Contracts
1934 capital
1934 contracts
Millions of Dollars
PREVIOUS 4 WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials

New Water Level Recorder Designed to be Waterproof

A new graphic water level recorder designed for simplicity and ability to withstand moisture has been introduced by W. & L. E. Gurley, Troy, N. Y. The gage operates on the principle of a clock rotating a vertically-mounted cylinder, the pen moving in a vertical plane to record the gage height.

The chart is 12 in. square, with a time scale of ½ in. per hour on the daily chart or 1½ in. per day on the weekly chart. The gage height scale is either natural scale for a 1-ft. range or a 1:10 scale for a 10-ft. range. Change in range scale is accomplished by changing the sheave wheels.



New Gurley water level recorder

Clocks may be either spring-wound or weight driven. They are enclosed in dust and watertight cases and are detachable when in need of service. An escapement lever outside the case permits close time regulation.

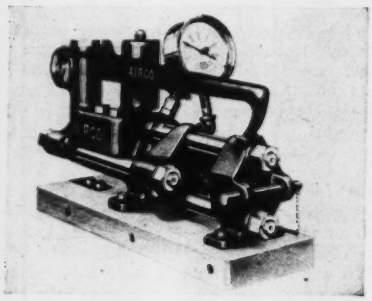
The chart cylinder rests upon a circular table which is rotated by the clock. The cylinder is held in place by its own weight.

A 7-in. float is regularly furnished although 5 in., 10 in. or 20 in. sizes can be supplied to special order. The recorder is 19¼ in. high and requires an additional 15½ in. of headroom to remove the cover. The base is supported on three feet which are contained within a 9 in. circle.

Portable Testing Machine For Weld Specimens

The Air Reduction Sales Co., New York, N. Y., has developed the Airco Portable Tensile and Bend Testing Machine, a compact, comparatively light machine that can be carried right to the welding job.

The machine consists essentially of an oil pump, a hydraulically actuated piston or ram, one fixed and one movable head for gripping the test specimens and four symmetrically located steel shafts, two of



Portable testing machine

which transmit the piston motion and load to the movable head. The other two shafts maintain the alignmen. of the two heads and prevent the introduction of bending stresses in the specimen.

Elevations Read Directly From New Level Rod

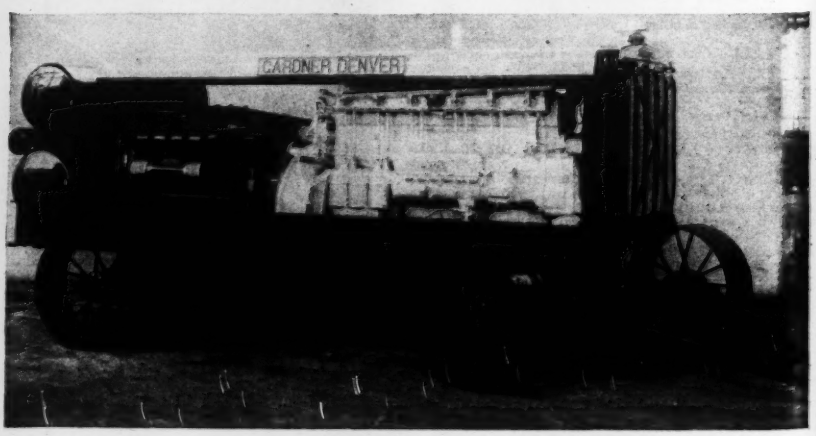
A new type of leveling rod designed to eliminate calculations to secure elevations or to set grades is announced by George G. Linn, Columbus, Ohio. It consists of a front slide with fractional foot graduations and with windows through which foot numerals graduated on a rear slide may be read. Both slides are adjustable vertically in an aluminum-alloy frame and by an adjustment of less than 1 ft. may be made to read any desired reading at the line

Level rod designed to eliminate calculations in determining elevations or setting grades

of sight. The rod is graduated from the top downward so the readings increase as the rod is held on points of greater elevation. By setting the slides to read the correct elevation on any point of known elevation, the readings taken on all other points will be actual elevations.

Diesel Portable Compressor

The Gardner-Denver Co., Quincy, Ill., has just announced a new line of diesel portable compressors. The new machines are powered with Caterpillar diesel engines.

The maker reports that in a recent test for fuel consumption and fuel cost, the unit cost 27.2 cents per hour for fuel, when using fuel at 6.2 cents per gallon and operating at full load, 100 lb. air pressure.

New portable compressor by Gardner-Denver, powered with Caterpillar diesel engine